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THIRD AMERICAN EDITION.

OF

Nicholson's

BRITISH ENCYCLOPEDIA

or Dictionary of

ARTS & SCIENCES

illustrated by upwards of 180 elegant Engravings.

PHILADELPHIA.

Published by Mitchell Ames & White.

W. Brown Printer.

1819

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OR

DICTIONARY

OF

ARTS AND SCIENCES.

COMPRISING

AN ACCURATE AND POPULAR VIEW

OF THE PRESENT

IMPROVED STATE OF HUMAN KNOWLEDGE.

BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

ILLUSTRATED WITH

UPWARDS OF 180 ELEGANT ENGRAVINGS.

VOL. IX. NIC......PHO.

PHILADELPHIA:

PUBLISHED BY MITCHELL, AMES, AND WHITE.

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THE

BRITISH ENCYCLOPEDIA.

NICERON.

NICERON (John Francis,) in biography, a French monk and ingenious mathematician in the seventeenth century, was born at Paris, in the year 1613. He early displayed a love of learning, and by the progress which he made in his elementary studies, afforded fair promise of future excellence. At the age of nineteen he entered into the order of Minims, and before he had gone through his course of philosophy, discovered that his predominant inclination was to the study of mathematical sciences, to which, after he had completed his theological course, he devoted all the time that was not necessarily occupied by the duties of his profession. The science of optics was what principally engaged his attention; and he left behind him, in different houses belonging to his order, particularly that at Paris, some excellent performances, which afforded satisfactory evidence of his profound skill in this branch of the mathematics. He was twice sent on business to Rome, and was appointed regent of the philosophical classes. Afterwards he was nominated to accompany father Francis de la Noue, vicar-general of the order, in his visitation of all the convents of Minims in France. The similarity of their taste proved the means of introducing him to the acquaintance of Des Cartes, who entertained a great regard for him, and made him a present of his "Principles of Philosophy." Their intimacy, however, which commenced in 1644, proved but of short duration, since our young monk fell sick at Aix, in Provence, and died there in the autumn of 1646, when he was only thirty-three years of age. This event was lamented as a considerable loss to the republic of letters. He was the author of the following works, which are held in high estimation. "The Interpretation of Cyphers, or, a Rule for the perfect Understanding and certain explanation of all Kinds of simple Cyphers, taken from the Italian of the Sieur Anthony Maria Cospi, secretary to the Grand Duke of Tuscany; enlarged, and particularly accommodated to the French and Spanish Languages," 1641, octavo; "Curious Perspective, or artificial Magic, produced by the wonderful Effects of Optics, Catoptrics, and Dioptrics," &c. 1638, folio; which was only introductory to his "Thaumaturgus Opticus, sive, admirandæ Optices, Catoptrices, et Dioptrices, Pars prima, de iis quæ spectant ad visionem directam," 1646, folio. On this work he was employed six years, and was prevented by his death from proceeding to the completion of the intended second and third parts, relating to the effects of reflection from plane, cylindrical, and conical mirrors, and the refraction of crystals. This task his friend father Mersenne undertook, not only by correcting what Niceron's papers in Latin and French would furnish towards it, but by supplying what might be necessary to perfect it. But the other occupations of this learned mathematician, during the two remaining years of his own life, prevented him from

finishing the work, which, upon his death, was committed for that purpose to M. de Roberval, professor royal of mathematics at Paris. A "Letter" of Father Niceron's is inserted in the third volume of Liceto's "De quæsitis per Epistolas."

NICHE, in architecture, a concave recess in a wall having a semi-circular or elliptical head, intended to contain a statue or bust.

NICKEL. A white metal, which, when obtained pure, is both ductile and malleable. It may be forged into very thin plates, their thickness not being greater than 0.01 of an inch. Its colour is intermediate between that of silver and tin, and is not altered by the air. It is nearly as hard as iron. Its specific gravity is 8.279, and when forged 8.666.

The species of nickel ores are, its alloy with arsenic, and a little sulphur and its oxide.

The first is the most abundant, and the one from which nickel is usually extracted. It is known to mineralogists by the name of kupfer-nickel, or copper-nickel, from its colour and appearance. It occurs generally massive and disseminated; its colour is copper-red of various shades; its lustre is weakly, shining, and metallic; it is perfectly opaque; its fracture is uneven; it is hard, has no malleability, but is not easily broken; its specific gravity is from 6.6 to 7.5. Urged by the flame of the blow-pipe, it gives vapours with a strong arsenical odour, and melts with difficulty. It dissolves in acids, giving a green solution. Bergman found it to be composed of nickel, iron, cobalt, arsenic, and sulphur. Vauquelin regards it as essentially an alloy of nickel and arsenic, the iron, cobalt, and sulphur, being accidental.

The other species, the oxide of nickel, occurs generally as an incrustation, sometimes also disseminated, of a friable texture and earthy appearance; of an apple green colour, without lustre. It is not altered by the heat of the blow-pipe; but when mixed with borax gives to it a yellowish red colour. Its solution in acids is of a green colour. It occurs generally with kupfer-nickel, or with certain cobalt ores. It is also contained in small quantities in a fossil of the siliceous genus, chrysoprase, to which it communicates an apple-green colour.

Nickel is extracted from the kupfer-nickel, but it is extremely difficult to free it entirely from the metals with which it is associated. The process given by Chenevix is the most simple. The metal obtained from kupfer-nickel, by roasting and fusion with three times its own weight of black flux, is dissolved in nitric acid, the solution being boiled, so that the arsenic present receiving oxygen from the acid may be converted into arsenic acid; a solution of nitrate of lead is then dropped in, and the liquor evaporated by a very gentle heat, but not quite to dryness. Alcohol poured into this solution precipitates every salt, but the nitrate of nickel, which has been formed by the double decomposition of the arseniate of nickel and the nitrate of lead. The alcohol of the solution of nitrate of nickel being evaporated, the metallic salt is redissolved in water and decomposed by potash. The oxide, well washed and dried, is reduced in an Hessian crucible lined with lamp-black.

By the experiments that have been made on nickel in its pure state, it appears to be proved that it is possessed of magnetic power, and that therefore iron is not the only metal to which it belongs. The magnetic properties of nickel had often been observed; but as, in the usual processes by which it is obtained, it is always alloyed with iron, it was concluded, with probability, that the magnetism it exhibited was owing to the presence of that metal. Since methods, however, have since been discovered of obtaining nickel in a purer state, the error of this conclusion has been discovered. The effect of the magnet on it is very little inferior to that which it exerts on iron; and the metal itself becomes magnetic itself by friction with a magnet, or even by beating with a hammer. Magnetic needles have even been constructed of it in France, and have been preferred to those of steel, as resisting better the action of the air. The nickel preserves its magnetic property when alloyed with copper, though it is somewhat diminished; by a small portion of arsenic it is completely destroyed.

Nickel is extremely fusible; its fusing point being higher than that of iron.

This metal is oxyded by exposure to the atmospheric air at a high temperature, though with difficulty. Its oxide is more easily obtained by exposure to heat with nitre; it is of an apple green colour, and is obtained likewise of this colour by precipitation from some of its saline combinations. It appears to be the oxide at the minimum of oxydement; at least, according to the experiments of Thenard, another oxide can be formed more high-

ly oxyded. It may be obtained by exposing the green oxide to a red heat, or by heating it with oxymuriatic acid. It appears, therefore, to be too highly oxydized to be capable of directly combining with any of the acids. According to Richter, oxide of nickel is reduced by heat alone; and the only difficulty experienced is the intensity of the heat required to fuse the metal.

Nickel is oxydized and dissolved by a number of acids; its solutions being generally of a green colour and crystallizable.

The salts of nickel are decomposed by the alkalies, and the oxide, more or less free from the acid, is thrown down. If the alkalies are added in excess, they redissolve it; and with ammonia, in particular, soluble triple salts are formed. Potash and soda dissolve even a small quantity of its pure oxide; ammonia dissolves it in a much larger quantity.

Nickel combines with sulphur by fusion. The compound has a yellow colour with some brilliancy. It is brittle and hard, and burns when strongly heated in contact with the air. Nickel is also dissolved by the alkaline sulphurets.

With phosphorus, nickel unites, either by projecting the phosphorus on the nickel at a high temperature, or by heating together phosphoric acid and nickel with a little charcoal. The nickel increases in weight one-fifth. The compound is of a white colour with metallic lustre, and appears composed of a congeries of prisms.

Nickel forms alloys with a number of the metals; but our knowledge of these combinations is very imperfect.

NICOTIANA, in botany, *tobacco*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel form, with a plaited border; stamina inclined; capsule two-valved, two-celled. There are seven species, of which N. rustica, English tobacco, seldom rises more than three feet in height, having smooth alternate leaves upon short foot stalks; flowers in small loose bunches on the top of the stalks, of a yellow colour, appearing in July, which are succeeded by roundish capsules, ripening in the autumn. Sir Walter Raleigh, on his return from America, is said to have first introduced the smoking of tobacco into England. In the house in which he lived at Islington, are his arms, with a tobacco plant on the top of the shield. It is remarkable, that tobacco has prevailed over the original name, petum, in all the European languages, with very little variation, and even in Tartary and Japan. Tobacco is derived from the island Tobago. Petum is the Brasilian name.

NICTITATING *membrane*, in comparative anatomy, a thin membrane, chiefly found in the bird and fish-kind, which covers the eyes of these animals, sheltering them from the dust, or from too much light; yet is so thin and pellucid, that they can see pretty well through it.

NIDUS, among naturalists, signifies a nest, or proper repository for the eggs of birds, insects, &c. wherein the young of these animals are hatched and nursed.

NIEUWENTYT, (BERNARD), in biography, a celebrated Dutch philosopher and mathematician, in the seventeenth and early part of the eighteenth century, was the son of a minister of Westgraafdyk, in North Holland, where he was born in the year 1654. He afforded early indications of a good genius, and a love of learning, which his father took care to encourage, by giving him the advantages of an excellent education. He was desirous of becoming acquainted with all the branches of knowledge; but he had the prudence and sagacity to proceed gradually in his acquirements, and to make himself master of one science, before he directed his attention to another. It was his father's wish, that he should be educated to his own profession; but when he found that his son was disinclined to such a destination, he very properly suffered him to follow the bent of his own genius. The first science to which young Nieuwentyt particularly directed his study, was logic, in order to fix his imagination, to form his judgment, and to acquire a habit of right reasoning; and in this science he grounded himself upon the principles of Des Cartes, with whose philosophy he was greatly delighted. In the next place, he engaged in the study of the mathematics, with the various departments of which he became intimately conversant.

He then entered upon the study of medicine, and the branches of knowledge more immediately connected with that science; and he afterward went through a course of reading on jurisprudence. In the study of all these sciences he succeeded so well, as deservedly to acquire the character of a good philosopher, a good mathematician, and an able just magistrate. From his writings it also appears, that he did not permit his various subjects of inquiry to divert his thoughts from a due attention to the great and fundamental principles of natural and revealed reli-

gion. He was naturally of a grave and serious disposition; but at the same time a very affable and agreeable companion. So engaging were his manners, that they conciliated the esteem of all his acquaintance; by which means he frequently drew over to his opinion, those who differed widely from him in sentiment. With such a character, he acquired great credit and influence in the council of the town of Puremerende, where he resided; and also in the states of that province, who respected him the more, because he never engaged in any cabals or factions, but recommended himself only by an open, manly, and upright behaviour. Had he aspired after some of the higher offices of government, there is no doubt but that his merits would have secured to him the suffrages of his countrymen; yet he preferred to such honours the cultivation of the sciences, contenting himself with being counsellor and burgomaster, without courting or accepting any other posts, which might interfere with his studies. He died in 1718, at the age of 63, having been twice married. He was the author of various works, among which are, "Considerationes circa Analyseos ad quantitates Infinite parvas applicatæ Principia, &c." 1694, octavo; in which he proposed some difficulties on the subject of the analysis of infinitessimals. "Analysis Infinitorum, seu Curvilineorum proprietates, ex Polygonorum deductæ," 1696, quarto; which is a sequel to the former, with attempts to remove those difficulties. "Considerationes Secundæ circa Calculi Differentialis Principiæ, et Responsio ad Virum nobilissimum G. G. Leibnitium,&c.' 1696, quarto; occasioned by an attack of Leibnitz on the author's "Analysis," in the Leipsic Journal for 1695. "A Treatise on the new Use of the Tables of Sines and Tangents," 1714. "The proper Use of the Contemplation of the Universe, for the Conviction of Atheists and Unbelievers," 1715, quarto; of which a French translation was published at Paris, in 1725, quarto, entitled, "L'Existence de Dieu demontrée par les Merveilles de la Nature;" and also an English one at London, in 1716, in three volumes, octavo, under the title of "The Religious Philosopher, or, the right Use of contemplating the Works of the Creator." A Memoir inserted in a Dutch Journal, entitled, "Bibliothéque de l'Europe," for the year 1716, in defence of the preceding work against a criticism of M. Bernard, in the "Nouvelles de la Republique des Lettres." "A Letter to M. Bothnia de Burmania, on his Article concerning Meteors," inserted in the "Nouvelles litter. du 22 Avril, 1719:" and about a month before his death, he put the finishing hand to an excellent refutation of Spinoza, which was published in Dutch at Amsterdam, in 1720, quarto.

NIGELLA, in botany, *fennel flower*, a genus of the Polyandria Pentagynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary five, two-lipped, within the corolla; capsule as many, connected. There are five species; these are annual herbaceous plants, with pinnate or bipinnate leaves, and linear leaflets; flowers terminating, in some species surrounded with a five-leaved calyx like multifid involucre.

NIGHT, that part of the natural day during which the sun is underneath the horizon; or that space wherein it is dusky. Night was originally divided by the Hebrews, and other eastern nations, into three parts, or watchings. The Romans, and afterwards the Jews from them, divided the night into four parts, or watches, the first of which began at sun-set and lasted till nine at night, according to our way of reckoning; the second lasted till midnight; the third till three in the morning; and the fourth ended at sun-rise.—The ancient Gauls and Germans divided their time not by days but by nights; and the people of Iceland and the Arabs do the same at this day. The like is also observed of our Saxon ancestors.

NIGHTINGALE. See MOTACILLA.

NIGRINE, in mineralogy, a species of the Menachine genus. Colour, dark brownish-black, passing to velvet black; it occurs in larger and smaller angular grains; specific gravity 4.5. It is not attracted by the magnet; it is infusible *per se*, but with borax it melts to a transparent hyacinth-red globule; it yields its menachine to acid of sugar. This species is found in Transylvania, consisting of yellow sand, intermixed with fragments of granite, gneiss, and mica-slate, and from which gold is obtained by washing. It comes to us commonly intermixed with grains of precious garnet, cyanite, and common sand. Its name is derived from its black colour; it is distinguished from menachanite by its stronger lustre, superior hardness, the colour of the streak, as well as by its not being in the smallest degree affected by the magnet, which also distinguishes it from iron-sand. Its constituent parts are,

Oxide of menachine	84
Oxide of iron	14
Oxide of manganese	2
	100

NILOMETER, sometimes called *Niloscope*, an instrument used among the ancients to measure the height of the water in the river Nile, in its periodical oveflowings. It was first set up, it has been asserted, by Joseph, during his government in Egypt. The measure of it was sixteen cubits, this being the height to which it must rise in order to insure the fruitfulness of the country.

NINTH, in music, an interval containing an octave and a tone; also a name given to the chord consisting of a common chord with the eighth advanced one note.

NIPA, in botany, a genus of the Appendix Palmæ class. Natural order of Palmæ or Palms. Essential character: male, spathe; corolla six-petalled: female, spathe; corolla, none; drupes angular. There is but one species, *viz.* N. fruticans, the young palm, is without the trunk; but in the adult state, it is some feet in height; leaves pinnate; pinnastriated, margined, and smooth; flowers male and female on the same palm; but distinct on different peduncles: males several, lateral, inferior, on dichotomous peduncles, in spikes: females terminating, aggregate in a globular head, sessile. It is a native of Java and other islands in the East Indies, where the leaves are used for covering houses and making mats. The fruit is eaten both raw and preserved.

NIPPLES, in anatomy. See MAMMARY *gland.*

NISI PRIUS, a commission directed to the judges of assize, empowering them to try all questions of fact issuing out of the courts at Westminster, that are then ready for trial by jury. The original of which name is this: all causes commenced in the courts of Westminster-hall, are, by course of the courts, appointed to be tried on a day fixed in some Easter or Michaelmas term, by a jury returned from the county where the cause of action arises; but with this proviso, *nisi prius justiciarii ad assisas capiendas venerint*: that is, unless before the day prefixed, the judges of assize came into the county in question, which they always do in the vacation preceding each Easter and Michaelmas term, and there try the cause; and then, upon the return of the verdict given by the jury to the court above, the judges there give judgment for the party for whom the verdict is found. All trials at law, in the civil courts, and at the assizes, are tried by this process, and are called trials at nisi prius.

NISSOLIA, in botany, so named in honour of Guill. Nissole, M. D. of Montpellier; a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx five-toothed; capsule one-seeded, ending in a ligulate wing. There are two species, *viz.* N. arborea, tree nissolia; and N. fruticosa, shrubby nissolia; both natives of Carthagena, in woods and coppices.

NITIDULA, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club solid, and nearly orbicular; shells margined; head prominent; thorax flattened, margined. There are about forty-two species enumerated by Gmelin, separated into sections according to the form of the lip. A. Lip cylindrical. B. Lip square. N. bipustulata, is oval, black; shells with a red dot. It inhabits Europe and America, and lives on carcases, meat, bacon, &c.

NITRARIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Ficoideæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled, with the petals arched at top; stamina fifteen or more; drupe one-seeded. There is but one species, *viz.* N. schoberi. Thick-leaved Nitraria.

NITRATES, in chemistry, salts formed of the nitric acid, and alkalies, earths, &c. They possess the following properties: soluble in water, and capable of crystallizing by cooling; when heated to redness with combustible bodies, a violent combustion and detonation is produced: sulphuric acid disengages from them fumes which have the odour of nitric acid: when heated with muriatic acid, oxymuriatic acid is driven off: they are decomposed by heat, and yield at first oxygen gas. There are twelve nitrates, of which the most important is the nitrate of potash, or nitre: this salt, known also by the name of salt-petre, is produced naturally in considerable quantities, particularly in Egypt, and has been known from time immemorial. Roger Bacon mentions it under the name of nitre, in the thirteenth century. The importance of this substance for the purposes of war, has led chemists to seek the best means of preparing it, especial-

ly as nature has not laid up large magazines of it, as she has of other salts. It is now ascertained, that nothing more is necessary for the production of nitre than a basis of lime, heat, and an open, but not too free communication with dry atmospheric air. When these circumstances combine, the acid is first formed, and afterwards the alkali. See NITRIC *acid.*

NITRE. See NITRATES. Nitre is found abundantly on the surface of the earth, in India, South America, South Africa, and even in some parts of Spain. In Germany and France it is obtained by means of artificial nitre-beds. These consist of the refuse of animal and vegetable bodies, undergoing putrefaction, mixed with calcareous and other earths. It has been ascertained, that if oxygen gas be presented to azote at the instant of its disengagement, nitric acid is formed. This seems to explain the origin of the acid in these beds. The azote, disengaged from these putrifying animal substances, combines with the oxygen of the air. The potash is probably furnished, partly at least, by the vegetables and the soil. The nitre is extracted from these beds, by lixiviating the earthy matters with water. This water, when sufficiently impregnated, is evaporated, and a brown-coloured salt obtained, known by the name of crude nitre. It consists of nitre, common salt, nitrate of lime, and various other salts. The foreign salts are either separated by repeated crystallizations, or by washing the salt repeatedly with small quantities of water: for the foreign salts being more soluble, are taken up first. Nitre, when slowly evaporated, is obtained in six-sided prisms, terminated by six-sided pyramids; but for most purposes, it is preferred in an irregular mass, because in that state it contains less water. The specific gravity of nitre, as ascertained by Dr. Watson, is 1.9. Its taste is sharp, bitterish, and cooling. It is very brittle. It is soluble in seven times its weight of water, at the temperature of 60°; and in rather less than its own weight of boiling water. When exposed to a strong heat it melts, and congeals by cooling into an opaque mass, which has been called mineral crystal. Whenever it melts, it begins to disengage oxygen; and, by keeping it in a red heat, about a third of its weight of that gas may be obtained: towards the end of the process azotic gas is disengaged. If the heat be continued long enough; the salt is completely decomposed, and pure potash remains behind. It detonates more violently with combustible bodies than any of the other nitrates. When mixed with one-third part of its weight of charcoal, and thrown into a red-hot crucible, or when charcoal is thrown into red-hot nitre, detonation takes place, and one of the most brilliant combustions that can be exhibited. The residuum is carbonate of potash. A still more violent detonation takes place, if phosphorus is used instead of charcoal. Nitre oxydizes all the metals at a red heat. The composition of nitre, according to Kirwan, is

Acid	44
Potash	51.8
Water	4.2
	100.0

Nitre furnishes all the nitric acid in all its states, employed either by chemists or artists: it is obtained by decomposing it by means of the sulphuric acid. When burnt with tartar, it yields a pure carbonate of potash. In the assaying of various ores it is indispensable, and is equally necessary in the analysis of many vegetable and animal substances. But one of the most important compounds, formed by means of nitre, is gunpowder, which has completely changed the modern art of war. The discoverer of this compound, and the person who first thought of applying it to the purposes of war, are unknown. It is certain, however, that it was used in the fourteenth century. From certain archives, quoted by Wiegleb, it appears that cannons were employed in Germany before the year 1372. No traces of it can be found in any European author, previous to the thirteenth century; but it seems to have been known to the Chinese long before that period. There is reason to believe, that cannons were used in the battle of Cressy, which was fought in 1346. They seem even to have been used three years earlier at the siege of Algesiras; but before this time, they must have been known in Germany, as there is a piece of ordnance at Amberg, on which is inscribed the year 1303. Roger Bacon, who died in 1292, knew the properties of gunpowder; but it does not follow that he was acquainted with its application to fire-arms. See GUNPOWDER. When three parts of nitre, two parts of potash, and one part of sulphur, all previously well dried, are mixed together in a warm mortar, the resulting compound is known by the name of fulminating powder. If a little of this powder be

put into an iron spoon, and placed upon burning coals, or held above the flame of a candle, it gradually blackens, and at last melts. At that instant it explodes with a very violent report, and a strong impression is made upon the bottom of the spoon, as if it had been pressed down very violently. This sudden and violent combustion is occasioned by the rapid action of the sulphur on the nitre. By the application of the heat, the sulphur and potash form a sulphuret, which is combustible at a lower heat probably than even sulphur. Sulphurated hydrogen gas, azotic gas, and perhaps also sulphurous acid gas, are disengaged almost instantaneously. It is to the sudden action of these on the surrounding air that the report is to be ascribed. Its loudness evidently depends upon the combustion of the whole powder at the same instant, which is secured by the previous fusion that it undergoes; whereas the grains of gunpowder burn in succession. A mixture of equal parts of tartar and nitre, deflagrated in a crucible, is known by the name of white flux. It is merely a mixture of carbonate of potash, with some pure potash. When two parts of tartar, and one of nitre, are deflagrated in this manner, the residuum is called black flux, from its colour. It is merely a mixture of charcoal and carbonate of potash.

Nitre is much used in medicine, in fevers as a cooling remedy, and as a diuretic in urinary affections. It is employed also in many arts, as in dying; and in domestic economy, for the preservation of animal substances used for food. To these substances it imparts a red colour. See Nitrous *acid;* also Gunpowder.

NITRIC *acid.* The two principal constituent parts of our atmosphere, when in certain proportions, are capable, under particular circumstances, of combining chemically, into one of the most powerful acids, the nitric, which consists, according to Mr. Davy, of 70.5 of oxygen, and 29.5 of azote, or nitrogen. If these gases be mixed in this proportion in a glass tube, about a line in diameter, over mercury, and a series of electric shocks be passed through them for some hours, they will form nitric acid; or, if a solution of potash be present with them, nitrate of potash will be obtained. The constitution of this acid may be further proved, analytically, by driving it through a red-hot porcelain tube, as thus it will be decomposed into oxygen and nitrogen gases. For all practical purposes, however, the nitric acid is obtained from nitrate of potash, from which it is expelled by sulphuric acid.

Four parts of pure nitrate of potash, coarsely powdered, are to be put into a glass retort, and three parts of concentrated sulphuric acid cautiously added, taking care to avoid the fumes that arise, which is best done by standing in a current of air, to convey them up the chimney. Join to the retort a tubulated receiver of large capacity, with an adopter interposed, and lute the junctures with a mixture of pipe-clay, sifted sand, and cut tow. In the tubulure fix with fat lute a glass tube terminating in another large receiver, in which is a small quantity of water; and, if you wish to collect the gaseous products, let a bent glass tube from this receiver communicate with a pneumatic trough. Apply heat to the receiver by means of a sand bath. The first product that passes into the receiver is generally red and fuming; but the appearances gradually diminish, till the acid comes over pale, and even colourless, if the materials used were clean. After this it again becomes more and more red and fuming, till the end of the operation; and the whole mingled together will be of a yellow or orange colour.

In the large way, and for the purposes of the arts, extremely thick cast iron or earthen retorts are usually employed, to which an earthen head is adapted, and connected with a range of proper condensers. The strength of the acid too is varied, by putting more or less water in the receivers. The nitric acid thus made generally contains sulphuric acid, and also muriatic, from the impurity of the nitrate employed. If the former, a solution of nitrate of barytes will occasion a white precipitate: if the latter, nitrate of silver will render it milky. The sulphuric acid may be separated by a second distillation from very pure nitre, equal in weight to an eighth of that originally employed; or by precipitating with nitrate of barytes, decanting the clear liquid, and distilling it. The muriatic acid may be separated by proceeding in the same way with nitrate of silver, or with litharge, decanting the clear liquor, and redistilling it, leaving an eighth or tenth part in the retort. The acid for the last process should be condensed as much as possible, and the redistillation conducted very slowly; and if it be stopped when half is come over, beautiful crystals of muriate of lead will be obtained on cooling the remainder, if litharge be used, as M. Steinacher informs us; who also adds, that the vessels should

be made to fit tight by grinding, as any lute is liable to contaminate the product.

As this acid still holds in solution more or less nitrous gas, it is not, in fact, nitric acid, but a kind of nitrous: it is therefore necessary to put it into a retort, to which a receiver is added, the two vessels not being luted, but merely joined by paper; and to apply a very gentle heat for several hours, changing the receiver as soon as it is filled with red vapours. The nitrous gas will thus be expelled, and the nitric acid will remain in the retort, as limpid and colourless as water. It should be kept in a bottle secluded from the light, otherwise it will lose part of its oxygen.

The strongest acid that Mr. Kirwan could procure at 60° was 1.5543, which by his calculation contained .7354 of real acid; but Rouelle professes to have obtained it of 1.583. It is observable, that, on comparing the tables of Kirwan and Davy, the aëriform acid appears to contain a considerable portion of water more than that which is combined with soda to form the nitrate.

Nitric acid should be of the specific gravity of 1.5, or a little more, and colourless. It boils at 248°, and may be distilled without any essential alteration. Exposed to the air it absorbs moisture. If two parts be suddenly diluted with one of water, the temperature will rise to about 112°; but the addition of more water to this diluted acid will lower its temperature. It retains its oxygen with little force, so that it is decomposed by all combustible bodies. Brought into contact with hrydogen gas at a high temperature, a violent detonation ensues, so that this must not be done without great caution. It inflames volatile oils, such as those of turpentine and cloves, when suddenly poured on them: but, to perform this experiment with safety, the acid must be poured out of a bottle tied to the end of a long stick, otherwise the operator's face and eyes will be greatly endangered. If it be poured on perfectly dry charcoal powder, it excites combustion, with the emission of copious fumes. By boiling it with sulphur it is decomposed, and its oxygen, uniting with the sulphur, forms sulphuric acid. Chemists in general agree, that it acts very powerfully on almost all the metals: but Baumé has asserted, that it will not dissolve tin; and Dr. Woodhouse of Pennsylvania affirms, that in a highly concentrated and pure state it acts not at all on silver, copper, or tin, though with the addition of a little water its action on them is very powerful. He does not mention the specific gravity of this acid: he only says, that it was prepared by first expelling the water of crystallization from nitre by heat, and then decomposing this nitre by means of strong sulphuric acid.

The nitric acid is of considerable use in the arts. It is employed for etching on copper; as a solvent of tin to form with that metal a mordant for some of the finest dyes; in metallurgy and assaying; in various chemical processes, on account of the facility with which it parts with oxygen and dissolves metals; in medicine as a tonic, and as a substitute for mercurial preparations in siphylis and affections of the liver; as also in the form of vapour, to destroy contagion. For the purposes of the arts it is commonly used in a diluted state, and contaminated with the sulphuric and muriatic acids, by the name of aqua fortis. This is generally prepared by mixing common nitre with an equal weight of sulphate of iron, and half its weight of the same sulphate calcined, and distilling the mixture: or by mixing nitre with twice its weight of dry powdered clay, and distilling in a reverberatory furnace. Two kinds are found in the shops, one called double aqua fortis, which is about half the strength of nitric acid; the other simply aqua fortis, which is half the strength of the double.

A compound made by mixing two parts of the nitric acid with one of muriatic, known formerly by the name of aqua regia, and now by that of nitro-muriatic acid, has the property of dissolving gold and platina. On mixing the two acids, heat is given out, an effervescence takes place, oxygenated muriatic acid gas is evolved, and the mixture acquires an orange colour. This is likewise made by adding gradually to an ounce of powdered muriate of ammonia, four ounces of double aqua fortis, and keeping the mixture in a sand-heat till the salt is dissolved; taking care to avoid the fumes, as the vessel must be left open: or by distilling nitric acid with an equal weight, or rather more, of common salt.

With the different bases the nitric acid forms nitrates.

The nitrate of barytes, when perfectly pure, is in regular octaëdral crystals, though it is sometimes obtained in small shining scales. It may be prepared by uniting barytes directly with nitric acid, or by decomposing the carbonate of sulphuret of barytes with this acid. Exposed to heat it decrepitates, and at length gives out its acid, which is decomposed;

but if the heat be urged too far, the barytes is apt to vitrify with the earth of the crucible. It is soluble in 12 parts of cold, and 3 or 4 of boiling water. It is said to exist in some mineral waters.

The nitrate of potash is the salt well known by the name of nitre, or saltpetre. It is found ready formed in the East Indies, in Spain, in the kingdom of Naples, and elsewhere, in considerable quantities; but nitrate of lime is still more abundant. Far the greater part of the nitrate made use of is produced by a combination of circumstances which tend to compose and condense nitric acid. This acid appears to be produced in all situations, where animal matters are completely decomposed with access of air, and of proper substances with which it can readily combine. Grounds frequently trodden by cattle, and impregnated with their excrements, or the walls of inhabited places where putrid animal vapours abound, such as slaughter-houses, drains, or the like, afford nitre by long exposure to the air. Artificial nitre beds are made by an attention to the circumstances in which this salt is produced by nature. Dry ditches are dug, and covered with sheds, open at the sides, to keep off the rain: these are filled with animal substances, such as dung, or other excrements, with the remains of vegetables, and old mortar, or other loose calcareous earth; this substance being found to be the best and most convenient receptacle for the acid to combine with. Occasional watering, and turning up from time to time, are necessary, to accelerate the process, and increase the surfaces to which the air may apply; but too much moisture is hurtful. When a certain portion of nitrate is formed, the process appears to go on more quickly: but a certain quantity stops it altogether, and after this cessation the materials will go on to furnish more, if what is formed be extracted by lixiviation. After a succession of many months, more or less, according to the management of the operation, in which the action of a regular current of fresh air is of the greatest importance, nitre is found in the mass. If the beds contained much vegetable matter, a considerable portion of the nitrous salt will be common saltpetre; but, if otherwise, the acid will, for the most part, be combined with the calcareous earth.

To extract the saltpetre from the mass of earthy matter, a number of large casks are prepared, with a cock at the bottom of each, and a quantity of straw within, to prevent its being stopped up. Into these the matter is put, together with wood-ashes, either strewed at top, or added during the filling. Boiling water is then poured on, and suffered to stand for some time; after which it is drawn off, and other water added in the same manner, as long as any saline matter can be thus extracted. The weak brine is heated, and passed through other tubs, until it becomes of considerable strength. It is then carried to the boiler, and contains nitre and other salts; the chief of which is common culinary salt, and sometimes muriate of magnesia.

It is the property of nitre to be much more soluble in hot than cold water; but common salt is very nearly as soluble in cold as in hot water. Whenever, therefore, the evaporation is carried by boiling to a certain point, much of the common salt will fall to the bottom, for want of water to hold it in solution, though the nitre will remain suspended by virtue of the heat. The common salt thus separated is taken out with a perforated ladle, and a small quantity of the fluid is cooled, from time to time, that its concentration may be known by the nitre which crystallizes in it. When the fluid is sufficiently evaporated, it is taken out and cooled, and great part of the nitre separates in crystal; while the remaining common salt continues dissolved, because equally soluble in cold and in hot water. Subsequent evaporation of the residue will separate more nitre in the same manner.

This nitre, which is called nitre of the first boiling, contains some common salt; from which it may be purified by solution in a small quantity of water, and subsequent evaporation: for the crystals thus obtained are much less contaminated with common salt than before; because the proportion of water is so much larger with respect to the small quantity contained by the nitre, that very little of it will crystallize. For nice purposes, the solution and crystallization of nitre are repeated four times. The crystals of nitre are usually of the form of six-sided flattened prisms, with diedral summits. Its taste is penetrating; but the cold produced, by placing the salt to dissolve in the mouth, is such as to predominate over the real taste at first. Seven parts of water dissolve two of nitre, at the temperature of sixty degrees: but boiling water dissolves its own weight. One hundred parts of alcohol, at a heat of one

hundred and seventy-six degrees, dissolve only 2.9.

On being exposed to a gentle heat, nitre fuses; and in this state being poured into moulds, so as to form little round cakes, or balls, it is called sal prunella, or crystal mineral. This at least is the way in which this salt is now usually prepared, conformably to the directions of Boerhaave; though in most dispensatories a twenty-fourth part of sulphur was directed to be deflagrated on the nitre, before it was poured out. This salt should not be left on the fire after it has entered into fusion, otherwise it will be converted into a nitrite of potash. If the heat be increased to redness, the acid itself is decomposed, and a considerable quantity of tolerably pure oxygen gas is evolved, succeeded by nitrogen.

This salt powerfully promotes the combustion of inflammable substances. Two or three parts mixed with one of charcoal, and set on fire, burn rapidly; azote and carbonic acid gas are given out, and a small portion of the latter is retained by the alkaline residuum, which was formerly called clyssus of nitre. Three parts of nitre, two of subcarbonate of potash, and one of sulphur, mixed together in a warm mortar, form the fulminating powder; a small quantity of which, laid on a fire shovel, and held over the fire till it begins to melt, explodes with a loud sharp noise. Mixed with sulphur and charcoal, it forms gunpowder. See GUNPOWDER.

Three parts of nitre, one of sulphur, and one of fine saw-dust, well mixed, constitute what is called the powder of fusion. If a bit of base copper be folded up and covered with this powder in a walnut shell, and the powder be set on fire with a lighted paper, it will detonate rapidly, and fuse the metal into a globule of sulphuret, without burning the shell.

If nitrate of potash be heated in a retort, with half its weight of solid phosphoric or boracic acid, as soon as this acid begins to enter into fusion, it combines with the potash, and the nitric acid is expelled, accompanied with a small portion of oxygen gas and nitric oxide.

Silex, alumine, and barytes, decompose this salt in a high temperature by uniting with its base, as was observed when speaking of aqua fortis. The alumine will effect this even after it has been made into pottery.

The uses of nitre are various. Beside those already indicated, it enters into the composition of fluxes, and is extensively employed in metallurgy: it serves to promote the combustion of sulphur in fabricating its acid; it is used in the art of dying; it is added to common salt for preserving meat, to which it gives a red hue; it is an ingredient in some frigorific mixtures; and it is prescribed in medicine, as cooling, febrifuge, and diuretic, and some have recommended it mixed with vinegar as a very powerful remedy for the sea scurvy.

Nitrate of soda, formerly called cubic or quadrangular nitre, approaches in its properties the nitrate of potash; but differs from it in being somewhat more soluble in cold water, though less in hot, which takes up little more than its own weight; in being inclined to attract moisture from the atmosphere; and in crystallizing in rhombs, or rhomboidal prisms. It may be prepared by saturating soda with the nitric acid, by precipitating nitric solutions of the metals, or of the earths, except barytes, by soda: by lixiviating and crystallizing the residuum of common salt distilled with three-fourths its weight of nitric acid; or by saturating the mother waters of nitre with soda instead of potash.

This salt has been considered as useless; but professor Proust says, that five parts of it, with one of charcoal and one of sulphur, will burn three times as long as common powder, so as to form an œconomical composition for fireworks.

Nitrate of strontian may be obtained in the same manner as that of barytes, with which it agrees in the shape of its crystals, and most of its properties. It is much more soluble, however, requiring but four or five parts of water according to Vauquelin, and only an equal weight according to Mr. Henry. Boiling water dissolves nearly twice as much as cold. Applied to the wick of a candle, or added to burning alcohol, it gives a deep red colour to the flame. On this account it might be useful, perhaps, in the art of pyrotechny.

Nitrate of lime, the calcareous nitre of older writers, abounds in the mortar of old buildings, particularly those that have been much exposed to animal effluvia, or processes in which azote is set free. Hence it abounds in nitre beds, as was observed when treating of the nitrate of potash. It may also be prepared artificially, by pouring dilute nitric acid on carbonate of lime. If the solution be

boiled down to a syrupy consistence, and exposed in a cool place, it crystallizes in long prisms, resembling bundles of needles diverging from a centre. These are soluble, according to Henry, in an equal weight of boiling water, and twice their weight of cold; soon deliquesce on exposure to the air; and are decomposed at a red heat. Fourcroy says, that cold water dissolves four times its weight, and that its own water of crystallization is sufficient to dissolve it at a boiling heat. It is likewise soluble in less than its weight of alcohol. By evaporating the aqueous solution to dryness, continuing the heat till the nitrate fuses, keeping it in this state five or ten minutes, and then pouring it into an iron pot previously heated, we obtain Baldwin's phosphorus. This, which is, perhaps, more properly nitrite of lime, being broken to pieces, and kept in a phial closely stopped, will emit a beautiful white light in the dark, after having been exposed some time to the rays of the sun. At present no use is made of this salt, except for drying some of the gases by attracting their moisture; but it might be employed instead of the nitrate of potash for manufacturing aqua fortis.

The nitrate of ammonia possesses the property of exploding, and being totally decomposed, at the temperature of 600°: whence it acquired the name of nitrum flammans. The readiest mode of preparing it is, by adding carbonate of ammonia to dilute nitric acid till saturation takes place. If this solution be evaporated in a heat between 70° and 100°, and the evaporation not carried too far, it crystallizes in hexaëdral prisms terminating in very acute pyramids; if the heat rise to 212°, it will afford, on cooling, long fibrous silky crystals: if the evaporation be carried so far as for the salt to concrete immediately on a glass rod by cooling, it will form a compact mass. According to Mr. Davy, these differ but little from each other, except in the water they contain, their component parts being as follows:

	contains of acid	ammonia	water
Prismatic	69.5	18.4	12.1
Fibrous	72.5	19.3	8.2
Compact	74.5	19.8	5.7

All these are completely deliquescent, but they differ a little in solubility. Alcohol at 176° dissolves nearly 90.9 of its own weight.

The chief use of this salt is for affording nitrous oxide on being decomposed by heat. See nitrous oxide, under the art. GAS.

Nitrate of Magnesia, magnesian nitre, crystallizes in four-sided rhomboidal prisms, with oblique or truncated summits, and sometimes in bundles of small needles. Its taste is bitter, and very similar to that of nitrate of lime, but less pungent. It is fusible, and decomposable by heat, giving out first a little oxygen gas, then nitrous oxide, and lastly nitric acid. It deliquesces slowly. It is soluble in an equal weight of cold water, and in but little more hot, so that it is scarcely crystallizable but by spontaneous evaporation.

The two preceding species are capable of combining into a triple salt, an ammoniaco-magnesian nitrate, either by uniting the two in solution, or by a partial decomposition of either by means of the base of the other. This is slightly inflammable when suddenly heated: and by a lower heat is decomposed, giving out oxygen, azote, more water than it contained, nitrous oxide, and nitric acid. The residuum is pure magnesia. It is disposed to attract moisture from the air, but is much less deliquescent than either of the salts that compose it; and requires eleven parts of water at 60° to dissolve it. Boiling water takes up more, so that it will crystallize by cooling. It consists of 78 parts of nitrate of magnesia and 22 of nitrate of ammonia.

From the activity of the nitric acid as a solvent of earths in analyzation, the nitrate of glucine is better known than any other of the salts of this new earth. Its form is either pulverulent, or a tenacious or ductile mass. Its taste is at first saccharine, and afterward astringent. It grows soft by exposure to heat, soon melts, its acid is decomposed into oxygen and azote, and its base alone is left behind. It is very soluble and very deliquescent.

Nitrate, or rather supernitrate, of alumine, crystallizes, though with difficulty, in thin, soft, pliable flakes. It is of an austere and acid taste, and reddens blue vegetable colours. It may be formed by dissolving in diluted nitric acid, with the assistance of heat, fresh precipitated alumine, well washed but not dried. It is deliquescent, and soluble in a very small portion of water. Alcohol dissolves its

own weight. It is easily decomposed by heat.

Nitrate of zircone was first discovered by Klaproth, and has since been examined by Guyton-Morveau and Vauquelin. Its crystals are small, capillary, silky, needles. Its taste is astringent. It is easily decomposed by fire, very soluble in water, and deliquescent. It may be prepared by dissolving zircone in strong nitric acid; but, like the preceding species, the acid is always in excess.

Nitrate of ittria may be prepared in a similar manner. Its taste is sweetish, and astringent. It is scarcely to be obtained in crystals; and if it be evaporated by too strong a heat, the salt becomes soft like honey, and on cooling concretes into a stony mass. Exposed to the air it deliquesces.

NITRITES. Though these salts are composed of nitrous acid and certain bases, yet the only way of obtaining them is by exposing a nitrate to a pretty strong heat, till a quantity of the oxygen gas is disengaged from it: what remains is a nitrite. These salts have never been minutely examined; but it is inferred, from the experiments that have been made, that they are, in general, deliquescent, very soluble in water, decomposable by heat, and by exposure to the air they are gradually converted into nitrates by absorbing oxygen.

NITROGEN. See ATMOSPHERE; also GAS.

NITROUS *acid.* It has already been observed, that there is no such thing, properly speaking, as nitrous acid, or the nitric base acidified with a minimum dose of oxygen; but that the nitric acid is capable of absorbing various portions of nitric oxide, with which it parts very readily, so that when in considerable quantity it gives it out in the ordinary state of the air, on mixing with which it assumes the appearance of a very red vapour. Hence it was formerly called fuming nitrous acid. It appears, however, to be capable of combining with some at least of the salifiable bases, so as to form a distinct genus of salts, that may be termed nitrites. But these cannot be formed by a direct union of their component parts; being obtainable only by exposing a nitrate to a high temperature, which expels a portion of its oxygen in the state of gas, and leaves the remainder in the state of a nitrite, if the heat be not urged so far, or continued so long, as to effect a complete decomposition of the salt. In this way the nitrates of potash and soda may be obtained, and perhaps those of barytes, strontian, lime, and magnesia. The nitrites are particularly characterized by being decomposable by all the acids except the carbonic, even by the nitric acid itself, all of which expel from it nitrous acid. We are little acquainted with any one except that of potash, which attracts moisture from the air, changes blue vegetable colours to green, is somewhat acrid to the taste, and when powdered emits a smell of nitric oxide.

NITROUS *oxide.* See GAS.

NOBILITY, a quality that ennobles and raises a person possessed of it above the rank of a commoner. The origin of nobility in Europe is by some referred to the Goths; who, after they had seized a part of Europe, rewarded their captains with titles of honour, to distinguish them from the common people. In Britain the term nobility is restrained to degrees of dignity above knighthood; but every where else nobility and gentility are the same. The British nobility consists only of five degrees, *viz.* that of a duke, marquis, earl or count, viscount, and baron, each of which see under their proper articles. In Britain these titles are only conferred by the King, and that by patent, in virtue of which it becomes hereditary. The privileges of the nobility are very considerable, they are all esteemed the King's hereditary counsellors, and are privileged from all arrests, unless for treason, felony, breach of peace, condemnation in parliament, and contempt of the king. They enjoy their seats in the House of Peers by descent, and no act of parliament can pass without their concurrence: they are the supreme court of judicature, and even in criminal cases give their verdict upon their honour, without being put to their oath. In their absence they are allowed a proxy to vote for them, and in all places of trust are permitted to constitute deputies, by reason of the necessity the law supposes them under of attending the King's person; but no peer is to go out of the kingdom without the King's leave, and when that is granted, he is to return with the King's writ, or forfeit goods and chattels.

NOBLE, a money of account, containing six shillings and eight-pence. The noble was anciently a real coin, struck in the reign of Edward III. and then called the penny of gold; but it was afterwards called a rose noble, from its being stamped with a rose.

NOCTURNAL, something relating to

the night, in contradistinction to diurnal.

Nocturnal *arch*, in astronomy, the arch of a circle described by the sun, or a star, in the night.

Nocturnal, *semi, arch of the sun*, is that portion of a circle he passes over between the lower part of our meridian and the point of the horizon, wherein he arises; or between the point of the horizon, wherein he sets, and the lower part of our meridian.

Nocturnal, or Nocturlabium, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night. Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole-star, and the pointers of the great bear.

This instrument consists of two circular plates applied to each other. The greater, which has a handle to hold the instrument, is about two inches and a half diameter, and is divided into twelve parts, agreeing to the twelve months, and each month subdivided into every fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth to be told in the night. Those at the hours twelve, are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, *viz.* the two circles and index, are joined by a rivet, which is pierced through the centre with a hole, through which the star is to be observed.

"To use the Nocturnal," turn the upper plate till the long tooth, marked twelve, be against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle, with the plane nearly parallel to the equinoctial; and viewing the pole-star through the hole of the centre, turn the index about till, by the edge coming from the centre, you see the bright star or guard of the little bear (if the instrument be fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour circle: which may be known without a light, by counting the teeth from the longest, which is for the hour twelve.

NODE, in surgery, a tumor arising on the bones, and usually proceeding from some venereal cause; being much the same with what is otherwise called exostosis.

NODES, in astronomy, the two points wherein the orbit of a planet intersects the ecliptic, whereof the node, where the planet ascends northwards, above the plane of the ecliptic, is called the ascending node, the northward node, and the head of the Dragon, and is marked thus ☊; the other node, where the planet descends to the south, is called the descending node, the southward node, or the Dragon's tail, marked thus ☋.

The line wherein the two circles intersect, is called the line of nodes. It appears from observation, that the line of the nodes of all the planets constantly changes its place, and shifts its situation from east to west, contrary to the order of the signs; and that the line of the Moon's nodes, by a retrogade motion, finishes its circulation in the compass of nineteen years; after which time, either of the nodes having receded from any point of the ecliptic, returns to the same again; and when the Moon is in the node, she is also seen in the ecliptic. If the line of nodes were immoveable, that is, if it had no other motion than that whereby it is carried round the Sun, it would always look to the same point of the ecliptic, or would keep parallel to itself, as the axis of the earth does.

From what has been said, it is evident that the Moon can never be observed precisely in the ecliptic but twice in every period; that is, when she enters the nodes. When she is at her greatest distance from the nodes, *viz.* in the points, she is said to be in her limits. The Moon must be in or near one of the nodes, when there is an eclipse of the Sun or Moon.

NOLANA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoleæ, or Luridæ. Borragineæ, Jussieu. Essential character: corolla bell-shaped; style among the germs; seeds five, berried, two-celled. There is but one species, *viz.* N. protrasta, trailing nolana.

NOLLE *prosequi*, is used where the plaintiff will proceed no further in his action, and may be as well before as after

a verdict, and is stronger against the plaintiff than a nonsuit, which is only a default in appearance; but this is a voluntary acknowledgment that he has no cause of action. In criminal cases it can only be entered by the Attorney General.

NOLLET (JOHN ANTHONY), in biography, a French ecclesiastic and celebrated natural philosopher in the eighteenth century, was born at Pimprè, in the diocese of Noyon, in the year 1700. His parents, who were persons of reputable character, though of humble fortunes, as they could not make him wealthy, determined to bestow on him the advantages of a good education. With this view they sent him to the college of Clermont in the Beauvoisin, and afterwards to Beauvais, where he laid a good foundation of grammar learning, which encouraged them to send him to Paris, in order to go through a course of philosophy at that university. It was their wish that he should embrace the ecclesiastical profession, and young Nollet adopted without repugnance the choice which they made for him. From a very early age he had shewn a taste for the study of natural philosophy, which had not yet become his ruling passion; he was, therefore, enabled to check himself in a pursuit which was likely to interfere with the studies more appropriate to his destined character, and gave himself up entirely to the study of scholastic theology. Having completed his academical course, and passed with reputation through the usual examinations, in 1728 he was admitted to deacon's orders, and soon became a licensed preacher. This new occupation, however, did not wholly divert his attention from the subjects of his early inquiries, and they insensibly claimed more and more of his time. At length his inclination for the sciences became irresistible, and he gave himself up to the study of natural philosophy, with an ardour to which the kind of privation in which he had so long lived gave augmented force. It was now his good fortune to become known to M. du Fay and M. Reaumur, and under their instructions his talents were rapidly developed. By the former he was received as an associate in his electrical researches; and the latter resigned to him his laboratory. He was also received into a Society of Arts, established at Paris under the protection of the Count de Clermont. In the year 1734, he accompanied M. M. du Fay, du Hamel, and de Jussieu, on a visit to England, where he had the honour of being admitted a foreign member of the Royal Society, and he profited so well of this visit, as to institute a friendly and literary correspondence with some of the most celebrated men in this country. Two years afterwards he made a tour to Holland, where he formed an intimate connection with s'Gravesande and Musschenbroek. Upon his return to Paris, he resumed a course of experimental philosophy, which he commenced in 1735, and which he continued to the year 1760. These courses of experimental physics gave rise to the adoption of similar plans in other branches of science, such as chemistry, anatomy, natural history, &c.

In the year 1738, the Count de Maurepas prevailed upon Cardinal Fleury to establish a public professorship of experimental philosophy at Paris, and the Abbé Nollet was the first person who received that appointment. During the following year, the Royal Academy of Sciences appointed him adjunct mechanician to that body; and in 1742 he was admitted an associate. In the year 1739, the King of Sardinia being desirous of establishing a professorship of physics at Turin, gave an invitation to the Abbé Nollet to perform a course of experimental philosophy before the royal family, with which he complied. From Turin he took a tour to Italy, where he collected some good observations concerning the natural history of the country. In the year 1744, he had the honour of being called to Versailles, to give lessons in natural philosophy to the Dauphin, at which the King and royal family were frequently present. By the excellence and amiableness of his personal character, as well as by his scientific talents, he recommended himself to the confidence of his illustrious pupil, who continued as long as he lived to express the greatest esteem for our philosopher. It is to be lamented that his liberality did not prompt him to better the mediocrity of his tutor's fortune. In the year 1749, the Abbé Nollet took a second journey into Italy, whence wonderful accounts had been circulated throughout Europe, of the communication of medicinal virtues by electricity, which seemed to be supported by numerous well-attested facts. To examine into these facts, and to be assured of their truth or fallacy, was one grand motive with our author in passing the Alps at this time, and in visiting the gentlemen who had published any accounts of those experiments. But though he engaged them to repeat their experiments in his presence, and upon himself, and though he made

it his business to get all the information which he could concerning them, he was soon convinced that the pretended facts were deceptions or exaggerations, and that no method had been discovered, by means of which the power of medicine could by electricity be made to insinuate itself into the human body. But these wonders were not the only objects which engaged our Abbé's attention in this visit to Italy; for his inquiries were extended to all the branches of natural philosophy, the arts, agriculture, &c. On his return to France, through Turin, the King of Sardinia made him an offer of the order of St. Maurice, which he thought it his duty to decline, not having the permission of his own sovereign for accepting it. In the year 1753, the King established a professorship of experimental philosophy at the Royal College of Navarre, and nominated the Abbé Nollet to fill that post. In the year 1757, the King bestowed on him the brevet of master of natural philosophy and natural history to the younger branches of the royal family of France; and in the same year appointed him professor of natural philosophy to the schools of artillery and engineers. Soon after this last preferment, he was received a pensionary of the Royal Academy of Sciences. This celebrated and laborious natural philosopher died in 1770, in the seventieth year of his age, regretted by the enlightened public, as well as the numerous friends whose attachment he had secured by the amiableness of his manners and the goodness of his heart; and more especially regretted by his poor relations, to whose relief and comfort he always paid the most affectionate attention. Besides the Royal Society of London, and the Royal Academy of Sciences at Paris, he was a member of the Institute of Bologna, the Academy of Sciences at Erfurt, and other philosophical societies and academies.

In addition to a multitude of papers inserted in the different volumes of the "Memoirs of the Academy of Sciences," from the year 1740 to the year 1767, both inclusive, the Abbé Nollet was the author of "Lessons on Experimental Philosophy," in six volumes, 12mo. "A Collection of Letters on Electricity," 1753, in three volumes, 12mo. "Enquiries into the particular Causes of Electric Phenomena," 12mo. and "The Art of making Philosophical Experiments," in three volumes, 12mo. From the articles just enumerated, as well as an anecdote already related in his life, it appears that Abbé Nollet paid particular attention to the study of electricity; and it must be acknowledged, notwithstanding the mistakes which he fell into upon the subject, that his indefatigable industry and curious experiments contributed materially to the improvement of that science. The theory of Affluences and Effluence of this philosopher, which gained considerable attention in his time, may be seen in Priestley's Electricity.

NO-*man's-land*, a space in midships, between the after-part of the belfry and the fore-part of a boat, when she is stowed upon the booms, as in a deep waisted vessel. These booms are laid upon the forecastle nearly to the quarter-deck, where their after-ends are usually sustained by a frame, called the gallows, which consists of two strong posts, about six feet high, with a cross piece reaching from one to the other athwart ships, and serving to support the ends of those booms, masts, and yards, which lie in reserve to supply the place of others carried away, &c. The above-named space is used to contain any blocks, ropes, tackles, &c. which may be necessary on the forecastle, and probably derives the name of no-man's-land from its situation, as being neither on the starboard nor larboard side of the ship, nor on the waist nor forecastle; but being situated in the middle, partakes equally of all those places.

NOMENCLATURE, a catalogue of several of the most useful words in any language, with their significations, compiled in order to facilitate the use of such words, to those who are to learn the tongue: such are our Latin, Greek, French, &c. nomenclatures.

NOMINATIVE, in grammar, the first case of nouns which are declinable. The simple position or laying down of a noun, or name, is called the nominative case; yet it is not so properly a case as the matter or ground whence the other cases are to be formed, by the several changes and inflections given to this first termination. Its chief use is to be placed in discourse before all verbs, as the subject of the proposition or affirmation.

NONAGISMAL, in astronomy, the 90th degree of the ecliptic, reckoned from the eastern term, or point. The altitude of the nonagesimal is equal to the angle of the east, and, if continued, passes through the poles of the ecliptic; whence the altitude of the nonagesimal at a given time, under a given elevation of the pole, is easily found. If the altitude of the nonagesimal be substracted from 90°, the

remainder is the distance of the nonagesimal from the vertex.

NONAGON, in mathematics, a figure having nine sides and angles. In a regular nonagon, or that the sides and angles of which are equal, if each side be 1, its area will be 6.182 nearly $= \frac{4}{9}$ of the tangent of 70° to the radius.

NON *claim*, in law, where a person has a demand upon another, and does not enforce his claim within a reasonable time, he is precluded by law from bringing his action to enforce it; and where a creditor neglects to make his claim upon a bankrupt's estate within a certain period, he will not be let in afterwards, so as to disturb the dividend, and may lose his estate. Non-claim is generally applied to the period of five years, after which a party is barred by a fine. See LIMITATION.

NON *est factum*, is a plea where an action is brought upon a bond, or any other deed, and the defendant denies it to be his deed whereon he is impleaded. In every case where the bond is void, the defendant may plead *non est factum;* but where a bond is voidable only, he must shew the special matter.

NON *pros*, if the plaintiff in an action at law neglect to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults, against the rules of law, in any subsequent stage of the action, he is adjudged not to pursue his remedy as he ought, and thereupon a non-suit, or *non prosequitur*, is entered, and he is then said to be non prosed.

NON *residence*, is applied to those spiritual persons who are not resident, but absent themselves for the space of one month together, or two months at several times in one year, from their dignities or benefices, which is liable to the penalties by the statute against non-residence, 21 Henry VIII. c. 13. But chaplains to the King, or other great persons mentioned in this statute, may be non-resident on their livings; for they are excused from residence whilst they attend those who retain them.

NON *suit*, where a person has commenced an action, and at the trial fails in his evidence to support it, or has brought a wrong action. There is this advantage attending a non-suit, that the plaintiff, though he pays costs, may afterwards bring another action for the same cause; which he cannot do, after a verdict against him.

NONCONFORMISTS, the same with dissenters. See DISSENTERS.

NONES, in the Roman calendar, the fifth day of the months January, February, April, June, August, September, November, and December; and the seventh of March, May, July, and October. March, May, July, and October, had six days in their nones; because these alone, in the ancient constitution of the year by Numa, had thirty-one days a-piece, the rest having only twenty-nine, and February thirty: but when Cæsar reformed the year, and made other months contain thirty-one days, he did not allot them six days of nones.

NORMAL, in geometry, signifies the same with a perpendicular, and is used for a line or plane that intersects another perpendicularly.

NORROY, that is *North Roy*, Northern King, in heraldry, the title of the third of the three kings at arms, or provincial heralds. His jurisdiction lies on the north side of the Trent, whence his name; as Clarencieux, on the south.

NOSE, the primary organ of smelling. See ANATOMY.

NOSTOCK, the name of a vegetable substance, which seems to differ from almost all others of the same kind. It is of a greenish colour, partly transparent, and of a very irregular figure. It trembles at the touch, like jelly, but does not melt like that. It is found in all sorts of soils, but most frequently in sandy ones, sometimes on the gravel of garden walks, usually after rain in the summer months.

NOSTRILS, in anatomy, the two apertures or cavities of the nose, through which the air passes, and which serve to convey odours, and to carry off the pituita separated in the sinuses of the base of the cranium.

NOT *guilty*, is the general issue or plea of the defendant in any criminal action or prosecution; as also in an action of trespass, or upon the case for deceits and wrongs; but not on a promise or assumpsit. It is the usual defence, where the party complains of a wrongful injury done to him.

NOTARY, is a person duly appointed to attest deeds and writings; he also protests and notes foreign and inland bills of exchange, and promissory notes, translates languages, and attests the same, enters and extends ship's protests, &c.

NOTATION, in arithmetic and algebra, the method of expressing numbers or quantities by signs or characters, appro-

priated for that purpose. See ARITHMETIC.

There is one thing which deserves particular notice, in regard to this subject, and that is, the great advantage that may redound to science by a happy notation, or expression of our thoughts. It is owing entirely to this, and the method of denoting the several combinations of numbers, by figures standing in different places, that the most complicated operations in arithmetic are managed with so much ease and dispatch. Nor is it less apparent that the discoveries made by algebra are wholly to be imputed to that symbolical language made use of in it: for by this means we are enabled to represent things in the form of equations: and by variously proceeding with these equations, to trace out, step by step, the several particulars we want to know. Add to all this, that by such a notation, the eyes and imagination are also made subservient to the discovery of truth; for the thoughts of the mind rise up and disappear, according as we set ourselves to call them into view; and, therefore, without some particular method of fixing and ascertaining them as they occur, the retrieving them when out of sight would be no less painful, than the very first exercise of deducing them one from another. As, therefore, we have frequent occasion to look back upon the discoveries already made, could these be no otherwise brought into view, than by the same course of thinking in which they were first traced, so many different attentions at once must needs greatly distract the mind, and be attended with infinite trouble and fatigue. But now, the method of fixing and ascertaining our thoughts by a happy and well chosen notation, entirely removes all those obstacles; for thus, when we have occasion to turn to any former discovery, as care is taken all along to delineate them in proper characters, we need only cast our eye on that part of the process where they stand expressed, which will lay them at once open to the mind in their true and genuine form. By this means we can take, at any time, a quick and ready survey of our progress, and running over the several conclusions already gained, see more distinctly what helps they furnish towards obtaining those others we are still in pursuit of. Nay, further, as the amount of every step of the investigation lies before us, by comparing them variously among themselves, and adjusting them one to another, we come at length to discern the result of the whole, and are enabled to form our several discoveries into an uniform and well connected system of truths, which is the end and aim of all our inquiries.

NOTES, in music, characters which mark the sounds; *i. e.* the elevations and fallings of the voice, and the swiftness and slowness of its motions. In general, under notes are comprehended all the signs or characters used in music, though in propriety the word only implies the marks which denote the degrees of gravity and acuteness to be given to each sound.

NOTONECTA, in natural history, *boat-fly*, a genus of insects of the order Hemiptera. Snout inflected; antennæ shorter than the thorax; four wings folded crosswise, coriaceous on the upper half; hind-legs hairy, formed for swimming. There are seventeen species, in two divisions, *viz.* A. Lip elongated, conic. B. Conic, spinous at the sides. N. Americana, grey, behind black; scutel deep black, with a yellow dot each side at the base; snout greenish at the base; margin and tip of the upper wings black; under wings black. It inhabits North America.

NOTOXUS, in natural history, a genus of insects of the order Coleoptera. Antennæ filiform; four feelers, hatchet-shaped; jaw one-toothed; thorax a little narrowed behind. There about thirteen species. N. monodon, thorax projecting over the head like a horn; testaceous; elytra with a black band and spots. It inhabits North America, and very much resembles N. monoceros of Europe.

NOVEL, in the civil law, a term used for the constitutions of several emperors, as of Justin, Tiberius, Leo, and more particularly of those of Justinian. The constitutions of Justinian were called novels, either from their producing a great alteration in the face of the ancient law, or because they were made on new cases, and, after the revisal of the ancient code, compiled by order of that emperor. Thus the constitutions of the emperors Theodosius, Valentinian, Marcian, &c. were also called novels, on account of their being published after the Theodosian code.

NOVEL *assignment*, or new assignment, a term in law pleadings, which it is difficult to explain to those unacquainted with practical pleading. It occurs in actions of trespass, where, the form of the declaration being very general, the defendant pleads in bar a common justification; to which the plaintiff replies, by stating that he brought his action as well for a certain other trespass, which be states

with more particularity, as for that which is justified. This is called a new assignment.

NOVEMBER, in chronology, the 11th month of the Julian year, consisting only of thirty days: it got the name of November, as being the ninth month of Romulus's year, which began with March.

NOUN, in grammar, a part of speech, which signifies things without any relation to time; as a man, a house, sweet, bitter, &c. See GRAMMAR.

NOURISHMENT. See PHYSIOLOGY.

NUDE *contract*, *nudum pactum*, a bare promise without any consideration, and not authenticated by deed, which is therefore void in law.

NUISANCE, signifies generally any thing that does hurt, inconvenience, or damage, to the property or person of another. Nuisances are of two kinds, public and private, and either affect the public or the individual. The remedy for a private nuisance is by action on the case for damages, and for a public nuisance by indictment. Amongst the nuisances which most commonly occur are the erecting of noxious manufactures in towns, and in the vicinity of ancient houses; such as the erecting a vitriol manufactory, to the annoyance of the neighbours in general. Disorderly houses, bawdy houses, stage booths, lotteries, and common scolds, are also public nuisances. Where the injury is merely to an individual, and not to the public, the individual only has an action, but not in the case of a public nuisance, where the private injury is merged, or lost, in that of the public, but where an individual receives a particular injury by a public nuisance. And any one aggrieved may abate, that is, pull down and remove a nuisance, after which he can have no action: but this is a dangerous attempt to take the law into one's own hands. It must be done without riot, if at all. Every continuance of a nuisance is a fresh nuisance, and a fresh action will lie.

NUL *tiel record*, no such record in law, is the replication which the plaintiff makes to the defendant, when the latter pleads a matter of record in bar to the action, and it is necessary to deny the existence of such record, and to join issue on that fact.

NUMBER, a collection of several units, or of several things of the same kind, as 2, 3, 4, &c. Number is unlimited in respect of increase, because we can never conceive a number so great, but still there is a greater. However, in respect of decrease it is limited; unity being the first and least number, below which therefore it cannot descend.

NUMBERS, *kinds and distinctions of.* Mathematicians, considering number under a great many relations, have established the following distinctions. Broken numbers, are the same with fractions. See ARITHMETIC. Cardinal numbers are those which express the quantity of units, as 1, 2, 3, 4, &c.; whereas ordinal numbers, are those which express order, as 1st, 2d, 3d, &c. Compound number, one divisible by some other number besides unity; as 12, which is divisible by 2, 3, 4 and 6. Numbers, as 12 and 15, which have some common measure besides unity, are said to be compound numbers among themselves. Cubic number, is the product of a square number by its root: such is 27, as being the product of the square number 9, by its root 3. All cubic numbers whose root is less than 6, being divided by 6, the remainder is the root itself: thus 27÷6 leaves the remainder 3, its root; 216, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which, added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which added to 6, is the cube root. Hence the remainders of the divisions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube so divided, till that remainder be 5, and consequently 11, the cube root of the number divided. But the cubic numbers above this being divided by 6, there remains nothing, the cube root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6; till you come to 18, when the remainder of the division must be added to 18; and so on *ad infinitum.* From considering this property of the number 6, with regard to cubic numbers, it has been found that all other numbers, raised to any power whatever, had each their divisor, which had the same effect with regard to them that 6 has with regard to cubes. The general rule is this: "If the exponent of the power of a number be even, that is, if that number be raised to the 2d, 4th, 6th, &c. power, it must be divided by 2; then the remainder added to 2, or to a multiple of 2, gives the root of the number corresponding to its power, that is the 2d, 4th, and root. But if the exponent of the power of the number be uneven,

the 3d, 5th, 7th power, the double of that exponent is the divisor that has the property required.

Determinate number, is that referred to some given unit, as a ternary or three: whereas an indeterminate one, is that referred to unity in general, and is called quantity. Homogeneal numbers, are those referred to the same unit; as those referred to different units are termed heterogeneal. Whole numbers are otherwise called integers. Rational number, is one commensurable with unity; as a number, incommensurable with unity, is termed irrational, or a surd. See SURD. In the same manner a rational whole number is that whereof unity is an aliquot part; a rational broken number, that equal to some aliquot part of unity; and a rational mixed number, that consisting of a whole number and a broken one. Even number, that which may be divided into two equal parts without any fraction, as 6, 12, &c. The sum, difference, and product of any number of even numbers, is always an even number. An evenly even number, is that which may be measured, or divided, without any remainder, by another even number, as 4 by 2. An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5. Uneven number, that which exceeds an even number, at least by unity, or which cannot be divided into two equal parts, as 3, 5, &c. The sum or difference of two uneven numbers make an even number; but the factum of two uneven ones make an uneven number. If an even number be added to an uneven one, or if the one be subtracted from the other, in the former case the sum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even. The sum of any even number of uneven numbers is an even number; and the sum of any uneven number of uneven numbers is an uneven number. Primitive, or prime numbers, are those only divisible by unity, as 5, 7, &c. And prime numbers among themselves, are those which have no common measure besides unity, as 12 and 19. Perfect number, that whose aliquot parts added together make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1, = 6; and those of 28 being 14, 7, 4, 2, 1, = 28. Imperfect numbers, those whose aliquot parts, added together, make either more or less than the whole. And these are distinguished into abundant and defective; an instance in the former case is 12, whose aliquot parts 6, 4, 3, 2, 1, make 16; and in the latter case 16, whose aliquot parts 8, 4, 2, and 1, make but 15. Plain number, that arising from the multiplication of two numbers, as 6, which is the product of 3 by 2; and these numbers are called the sides of the plane. Square number, is the product of any number multiplied by itself: thus 4, which is the factum of 2 by 2, is a square number. Every square number added to its root makes an even number. Polygonal, or polygonous numbers, the sums of arithmetical progressions beginning with unity: these, where the common difference is 1, are called triangular numbers; where 2, square numbers; where 3, pentagonal numbers; where 4, hexagonal numbers; where 5, heptagonal numbers, &c. See POLYGONAL. Pyramidal numbers: the sums of polygonous numbers, collected after the same manner as the polygons themselves, and not gathered out of arithmetical progressions, are called first pyramidal numbers: the sums of the first pyramidals are called second pyramidals, &c. If they arise out of triangular numbers, they are called triangular pyramidal numbers; if out of pentagons, first pentagonal pyramidals. From the manner of summing up polygonal numbers, it is easy to conceive how the prime pyramidal numbers are found, *viz.* $\frac{(a-2)n^3 + 3n^2 - (a-5)n}{6}$ expresses all the prime pyramidals.

NUMBER *of direction*, in chronology, some one of the 35 numbers between the Easter limits, or between the earliest and latest day on which it can fall; *i. e.* between the 22d of March and the 25th of April. Thus, if Easter Sunday fall as in the first line below, the number of direction will be as on the lower line.

	March.										April.			
Easter-day	22,	23,	24,	25,	26,	27,	28,	29,	30,	31.	1,	2,	3,	&c.
Number of direction	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13,	&c.

and so on, till the number of direction and the sum will be so many days in March for the Easter-day; if the sum exceed 31, the excess will be the day of April. To find the number of direction: enter the following table with the dominical letter on the left hand, and the golden number at top; then where the columns meet is the number of direction for that year.

G. N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Dom. Let.																			
A	29	19	5	26	12	33	19	12	26	19	5	26	12	5	26	12	33	19	12
B	27	13	6	27	13	34	20	13	27	20	6	27	13	6	20	13	34	20	6
C	8	4	7	21	14	35	21	7	28	21	7	28	14	7	21	14	28	21	7
D	19	15	8	22	15	29	22	8	29	15	8	29	15	1	22	15	29	22	8
E	30	16	2	23	16	30	23	9	30	16	9	23	16	2	23	9	30	23	9
F	24	17	3	24	10	31	24	10	31	17	10	24	17	3	24	10	31	17	10
G	25	18	4	25	11	32	18	11	32	18	4	25	18	4	25	11	32	18	11

Thus, for the year 1808, the dominical letter being B, and the golden number 4, we find the number of direction 27, to which add 21, and the sum is 48 from the 1st of March, deduct 31 for the number of days in March, and the remainder gives the day of April for Easter Sunday.

NUMBER, *golden*, in chronology. See GOLDEN *number*.

NUMBER, in grammar, a modification of nouns, verbs, &c. to accommodate them to the varieties in their objects, considered with regard to number. See GRAMMAR.

NUMBERS, in poetry, oratory, music, &c. are certain measures, proportions, or cadences, which render a verse, period, or song, agreeable to the ear.

NUMERAL *letters*, those letters of the alphabet which are generally used for figures, as I, V, X, L, C, D, M.

NUMERATION, or *notation*, the art of expressing in characters any number proposed in words; or of expressing in words any number proposed in characters. See ARITHMETIC; NOTATION.

NUMERICAL, or NUMERAL, something belonging to numbers; as numerical algebra is that which makes use of numbers instead of letters of the alphabet. Also, numerical difference is the difference whereby one individual is distinguished from another. Hence a thing is said to be numerically the same, when it is so in the strictest sense of the word.

NUMIDIA, the PINTADO, or *guinea-hen*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill strong and short, with a carunculate cere at the base, in which the nostrils are lodged; head horned, with a compressed coloured callus; wattles hanging from the cheeks; tail short, and pointing downwards; body speckled. There are four species. N. meleagris, is of the size of a very large fowl, and is the meleagris of the ancients, who used to prize it as a high delicacy. Its native territory is Africa, and particularly, perhaps, Nubia. It is gregarious, having been often seen in very numerous flocks. It is now extremely common in this country. The female lays many eggs, and, secreting her nest, sometimes will suddenly appear with a family of twenty young ones. It is a bird of harsh sound, and almost perpetually uttering it. The flesh of the young birds is valued, and its eggs are thought preferable to those of the common hen. See Aves, Plate X. fig. 5.

NUNEZ (PERO), in biography, one of the ablest mathematicians of his time, born at Alcaza do Sal, in Portugal. He taught publicly in the university of Coimbra, and instructed the Infante de Luis so well, that it is said he fitted him for a professor. Pero Nunez is well known, in the history of science, as the person who made the first improvement in the method of reading an observed angle, and the scale which he invented for this purpose, though it has received some improvements, is still called the Nonius, his latinized name. His works are numerous.

NUT-*galls* are excrescences formed on leaves of the oak by the puncture of an insect, which deposits an egg in them. The best are known by the name of Aleppo-galls, imported very largely into this country for the use of dyers, calico-printers, &c. These are hard like wood, of a blueish colour, and of a disagreeable taste. They are partly soluble in water, and what remains is tasteless and possesses the properties of the fibre of wood. By experiments Mr. Davy found that 500 grains of Aleppo-galls formed with water a solu-

tion, which yielded by slow evaporation 185 grains of matter, which was composed of

Tannin	130
Gallic acid and extract	31
Mucilage and extract	12
Lime and saline matter	12
	185

See TANNIN.

NUTATION, in astronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution it is twice inclined to the ecliptic, and as often returns to its former position.

Sir Isaac Newton observes, that the moon has the like motion, only very small, and scarcely sensible.

NUTMEG, in natural history, the kernel of a large fruit, not unlike the peach, the produce of a tree called, by botanists, MYRISTICA, which see.

The nutmeg is separated from its investient coat, the mace, before it is sent over to us; except that the whole fruit is sometimes imported in preserve, by way of sweetmeat, or as a curiosity. See MACE.

The nutmeg, as we receive it, is of a roundish or oval figure, of a tolerably compact and firm texture, but easily cut with a knife, and falling to pieces on a smart blow. Its surface is not smooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyish brown colour on the outside, and of a beautiful variegated hue within, being marbled with brown and yellow variegations, running in perfect irregularity through its whole substance. It is very unctuous and fatty to the touch, when powdered, and is of an extremely agreeable smell, and of an aromatic taste, without the heat that attends that kind of flavour in most of the other species.

There are two kinds of nutmeg in the shops, the one called by authors the male, and the other the female. The female is the kind in common use, and is of the shape of an olive: the male is long and cylindric, and has less of the fine aromatic flavour than the other, so that it is much less esteemed, and people who trade largely in nutmegs will seldom buy it. Besides this oblong kind of nutmegs, we sometimes meet with others of perfectly irregular figures, but mere lusus naturæ, not owing to a different species of the tree. The longer male nutmeg, as we term it, is called by the Dutch the wild nutmeg. It is always distinguishable from the others, as well by its want of fragrancy, as by its shape: it is very subject to be worm-eaten, and is strictly forbid, by the Dutch, to be packed up among the other, because it will give occasion to their being worm-eaten by the insects getting from it into them, and breeding in all parts of the parcel. The largest, heaviest, and most unctuous of the nutmegs are to be chosen, such as are the shape of an olive, and of the most fragrant smell.

NUTRITION. See PHYSIOLOGY.

NYCTANTHES, in botany, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla, salver shaped, with truncated segments; capsule, two-celled, margined; seeds solitary. There are seven species, of which N. undulata, wave-leaved Nyctanthes, is a shrub about six feet in height, the young shoots are hairy; leaves of a shining green, smooth, in pairs from the joints, bitter, without any smell; flowers white; calycine segments six; of the corolla six, seven or eight, narrow, much waved on the edge; fruit superior, resembling a black cherry, containing a round hairy seed. It is a native of the East Indies, where it is much cultivated on account of the sweetness of the flowers, which are worn by the ladies in their hair.

NYMPH, or PUPA, among naturalists, that state of winged-insects between their living in the form of a worm, and their appearing in the winged or most perfect state.

The eggs of insects are first hatched into a kind of worms, or maggots; which afterwards pass into the nymph-state, surrounded with shells or cases of their own skins; so that, in reality, these nymphs are only the embryo-insects, wrapped up in this covering; from whence they at last get loose, though not without great difficulty.

Linnæus applied the term Pupa to this state of the insect, from a fancied resemblance which it bears to a child wrapped in swaddling clothes, according to the old European fashion.

NYMPHÆ. See ANATOMY.

NYMPHÆA, in botany, *water-lily*, a genus of the Polyandria Monogynia class and order. Natural order of Succulentæ. Hydrocharides, Jussieu. Essential character, calyx four, five, or six leaved; co-

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rolla many petalled; berry many celled, truncated. There are six species, of which N. alba, white water-lily, has a tuberous root, creeping far and wide in the mud; the whole plant is larger than the yellow water-lily; petioles and peduncles round, within full of pores; flowers large and very handsome, petals white, from sixteen to twenty in number; stamens sixty-eight, or seventy; germ roundish; style none; stigma rayed; according to Linnæus, the flower raises itself out of the water and expands about seven o'clock in the morning, closing again, and reposing upon the surface of the water soon after four in the evening.

The roots have an astringent bitter taste; they are used in Ireland, and in the Highlands of Scotland, to dye a dark brown or chesnut colour; this plant is a native of most parts of Europe, in slow streams, pools and ditches, flowering in July and August.

NYSSA, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Holoraceæ. Elæagmi, Jussieu. Essential character: calyx, five parted; corolla none: male, stamens ten: hermaphrodite, stamens five; pistil one; drupe inferior. There are two species, *viz.* N. integrifolia, mountain tupelo; and N. denticulata, water tupelo; the former of which grows naturally in Pennsylvania, rising to the height of thirty or forty feet, and nearly two in diameter, sending off many horizontal and often depending branches; leaves of a dark green colour on the upper surface, but lighter underneath; the flowers are produced upon long footstalks, from the base of the young shoots, dividing irregularly into several parts, each supporting a small flower; the female trees have fewer flowers, produced upon much longer simple cylindrical footstalks. The Virginian water tupelo tree grows naturally in wet swamps, or near large rivers in Carolina and Florida, rising with a strong upright trunk to the height of eighty or an hundred feet, dividing into many branches towards the top; the leaves are large, of an oval spear-shaped form; the berries are nearly the size and shape of small olives, and are preserved by the French inhabitants upon the Mississippi, where it abounds, and is called the olive tree.

O.

O, or o, the fourteenth letter, and fourth vowel of our alphabet, pronounced as in the words *nose, rose*, &c.

The sound of this letter is often so soft as to require it double, and that chiefly in the middle of words; as *goose, reproof*, &c. and in some words this *oo* is pronounced like *u* short, as in *flood, blood*, &c.

As a numeral, O is sometimes used for eleven; and with a dash over it, thus, $\overline{\text{O}}$, for eleven thousand.

In music, the O, or rather a circle, or double CƆ, is a note of time, called by us a semi-breve; and, by the Italians, circolo. The O is also used as a mark of triple time, as being the most perfect of all figures. See Triple.

OAK. See Quercus.

OAKUM, old ropes untwisted, and pulled out into loose hemp, in order to be used in caulking the seams, tree nails, and bends of a ship, for stopping or preventing leaks.

OAR, in navigation, a long piece of wood, made round where it is to be held in the hand, and thin and broad at the other end, for the easier cutting and resisting the water, and consequently moving the vessel, by rowing.

OAT. See Avena.

OBELISK, in architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

OBJECT, in philosophy, something apprehended, or presented to the mind, by sensation or by imagination.

Object *glass of a telescope, or microscope*, the glass placed at the end of the tube which is next the object.

To prove the goodness and regularity of an object-glass, on a paper, describe two concentric circles, the one having its diameter the same with the breadth of the object-glass, and the other half that diameter; divide the smaller circumfer-

ence into six equal parts, pricking the points of division through with a fine needle; cover one side of the glass with this paper, and, exposing it to the sun, receive the rays through these six holes upon a plane; then by moving the plane nearer to, or further from the glass, it will be found whether the six rays unite exactly together at any distance from the glass; if they do, it is a proof of the regularity and just form of the glass; and the said distance is also the focal distance of the glass. A good way of proving the excellency of an object-glass, is by placing it in a tube, and trying it with small eye-glasses, at several distant objects; for that object-glass is always the best which represents objects the brightest and most distinct, and which bears the greatest aperture, and the most convex and concave eye-glasses, without colouring or haziness. A circular object-glass is said to be truly centered when the centre of its circumference falls exactly in the axis of the glass; and to be ill centered when it falls out of the axis. To prove whether object-glasses be well centered, hold the glass at a due distance from the eye, and observe the two reflected images of a candle, varying the distance till the two images unite, which is the true centre point: then if this fall in the middle, or central point of the glass, it is known to be truly centered. As object-glasses are commonly included in cells that screw upon the end of the tube of a telescope, it may be proved whether they be well centered by fixing the tube, and observing, while the cell is unscrewed, whether the cross-hairs keep fixed upon the same lines of an object seen through the telescope.

OBJECTIVE *line*, in perspective, is any line drawn on the geometrical plane, whose representation is sought for in a draught or picture: and the *objective plane* is any plane situated in the horizontal plane, the representation of which is required. See PERSPECTIVE.

OBLATE, flattened, or shortened, as an oblate spheroid, having its axis shorter than its middle diameter, being formed by the rotation of an ellipse about the shorter axis. The oblateness of the earth refers to the diminution of the polar axis in respect of the equatorial. The ratio of these two axes has been determined in various ways; sometimes by the measures of different degrees of latitude, and sometimes by the length of pendulums, vibrating seconds in different latitudes. See EARTH, DEGREE, &c.

OBLIGATION, in law, a bond containing a penalty, with a condition annexed, either for payment of money, performance of covenants, or the like. This security is called a specialty. See BOND and DEED.

OBLIGOR, in law, he who enters into an obligation; as obligee is the person to whom it is entered into.

OBLIQUE, in geometry, something aslant, or that deviates from the perpendicular. Thus an oblique angle is either an acute or obtuse one, *i. e.* any angle except a right one. See ANGLE.

OBLIQUE *cases*, in grammar, are all the cases except the nominative.

OBLIQUE *line*, that which, falling on another line, makes oblique angles with it, *viz.* one acute, and the other obtuse.

OBLIQUE *planes*, in dialling, are those which recline from the zenith, or incline towards the horizon.

The obliquity, or quantity of this inclination, or reclination, may be found by means of a quadrant.

OBLIQUE *sailing*, in navigation, is when a ship sails upon some rhumb between the four cardinal points, making an oblique angle with the meridian; in which case she continually changes both latitude and longitude. Oblique sailing is of three kinds, *viz.* plain sailing, Mercator's sailing, and great circle sailing. See NAVIGATION.

OBLIQUE *sphere*, is where the pole is elevated any number of degrees less than 90°: in which case the axis of the world, the equator, and parallels of declination, will cut the horizon obliquely.

OBLIQUITY *of the ecliptic*. See ECLIPTIC.

OBLIQUUS, in anatomy, *oblique*, a name given to several muscles, particularly in the head, eyes, and abdomen. See ANATOMY.

OBOLARIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx two-leaved; corolla four-cleft, bell-shaped; stamina, from the slits of the corolla; capsule one-celled, two-valved, many-seeded. There is but one species, *viz.* O. Virginica.

OBSERVATION, in astronomy and navigation, is the observing with an instrument some celestial phenomenon, as the altitude of the sun, moon, and stars, or their distances from each other. But by this term, mariners commonly mean only the taking the meridian altitudes, in order to find the latitude; and the finding

the latitude from such observed latitude, they call "working an observation."

OBSERVATORY, a place destined for observing the heavenly bodies; it is a building usually in form of a tower, erected on an eminence, and covered with a terrace for making astronomical observations. Most nations have had observatories, which have been noticed at large in La Lande's Astronomy: of these, the following may be mentioned:

The Greenwich Observatory, or Royal Observatory of England. This was built and endowed in the year 1676, by order of King Charles the Second, at the instance of Sir Jonas Moore, and Sir Christopher Wren; the former of these gentlemen being Surveyor General of the Ordnance, the office of Astronomer Royal was placed under that department, in which it has continued ever since.

This observatory was at first furnished with several very accurate instruments; particularly a noble sextant of seven feet radius, with telescopic sights. And the first Astronomer Royal, or the person to whom the province of observing was first committed, was Mr. John Flamsteed; a man who, as Dr. Halley expresses it, seemed born for the employment. During fourteen years he watched the motions of the planets with unwearied diligence, especially those of the moon, as was given him in charge; that a new theory of that planet being found, shewing all her irregularities, the longitude might thence be determined. In the year 1690, having provided himself with a mural arch of near seven feet radius, made by his assistant, Mr. Abraham Sharp, and fixed in the plane of the meridian, he began to verify his catalogue of the fixed stars, which had hitherto depended altogether on the distances measured with the sextant, after a new and very different manner, *viz.* by taking the meridian altitudes, and the moments of culmination, or in other words, the right ascension and declination. And he was so well pleased with this instrument, that he discontinued almost entirely the use of the sextant. Thus, in the space of upwards of forty years, the Astronomer Royal collected an immense number of good observations; which may be found in his "Historia Cœlestis Britannica," published in 1725; the principal part of which is the Britannic Catalogue of the fixed stars.

Mr. Flamsteed, on his death in 1719, was succeeded by Dr. Halley, and he by Dr. Bradley in 1742, and this last by Mr. Bliss in 1762; but none of the observations of these gentlemen have yet been given to the public.

On the demise of Mr. Bliss, in 1765, he was succeeded by Dr. Nevil Maskelyne, the present Astronomer Royal, whose valuable observations have been published, from time to time, under the direction of the Royal Society, in several folio volumes.

The Greenwich Observatory is found, by very accurate observations, to lie in 51° 28′ 40″ north latitude, as settled by Dr. Maskelyne, from many of his own observations, as well as those of Dr. Bradley.

The Paris Observatory was built by Louis the Fourteenth, in the Fauxbourg St. Jaques; being begun in 1664, and finished in 1672. It is a singular but magnificent building, of eighty feet in height, with a terrace at top; and here M. de la Hire, M. Cassini, &c. the King's Astronomers, have made their observations. Its latitude is 48° 50′ 14″ north, and its longitude 9′ 20″ east of Greenwich Observatory.

In the Observatory of Paris is a cave, or pit, 170 feet deep, with subterraneous passages, for experiments that are to be made out of the reach of the sun, especially such as relate to congelations, refrigerations, &c. In this cave there is an old thermometer of M. de la Hire, which stands at all times at the same height; thereby shewing that the temperature of the place remains always the same. From the top of the platform to the bottom of the cave is a perpendicular well or pit, used formerly for experiments on the fall of bodies; being also a kind of long telescopical tube, through which the stars are seen at mid-day.

Tycho Brahe's Observatory was in the little island Ween, or the Scarlet Island, between the coasts of Schonen and Zealand, in the Baltic Sea. This observatory was not well situated for some kinds of observations, particularly the risings and settings; as it lay too low, and was landlocked on all the points of the compass except three; and the land horizon being very rugged and uneven.

Pekin Observatory. Father Le Compte describes a very magnificent observatory, erected and furnished by the late Emperor of China, in his capital, at the intercession of some Jesuit missionaries, chiefly Father Verbest, whom he appointed his chief observer. The instruments here are exceedingly large; but the divisions are less accurate; and, in some respects, the contrivance is less commodious than

in those of the Europeans. The chief are, an armillary zodiacal sphere of six Paris feet diameter, an azimuthal horizon six feet diameter, a large quadrant six feet radius, a sextant eight feet radius, and a celestial globe six diameter.

Bramin's Observatory at Benares, in the East Indies, which is still one of the principal seminaries of the Bramins, or priests of the original Gentoos of Hindostan. This observatory at Benares, it is said, was built about 200 years since, by order of the Emperor Ackbar; for as this wise prince endeavoured to improve the arts, so he wished also to recover the sciences of Hindostan, and therefore ordered that three such places should be erected; one at Delhi, another at Agra, and the third at Benares.

Wanting the use of optical glasses, to magnify very distant, or very small objects, these people directed their attention to the increasing the size of their instruments, for obtaining the greater accuracy and number of the divisions and subdivisions in their instruments. Accordingly, the observatory contains several huge instruments of stone, very nicely erected and divided, consisting of circles, columns, gnomons, dials, quadrants, &c. some of them of 20 feet radius, the circle divided first into 360 equal parts, and sometimes each of these into 20 other equal parts, each answering to 3′, and of about two tenths of an inch in extent. And although these wonderful instruments have been built upwards of 200 years, the graduations and divisions on the several arcs appear as well cut, and as accurately divided, as if they had been the performance of a modern artist. The execution, in the construction of these instruments, exhibits an extraordinary mathematical exactness in the fixing, bearing, fitting of the several parts, in the necessary and sufficient supports to the very large stones that compose them, and in the joining and fastening them into each other by means of lead and iron.

We have referred to this article from the EQUATORIAL, for some account of practical astronomy, and the instruments used in this branch of science.

By practical astronomy is implied the knowledge of observing the celestial bodies, with respect to their position and time of the year, and of deducing from those observations certain conclusions, useful in calculating the time when any proposed position of these bodies shall happen. For this purpose, it is necessary to have a room or place conveniently situated, suitably contrived, and furnished with proper astronomical instruments. It should have an uninterrupted view from the zenith down to, or even below, the horizon, at least towards the cardinal points; and for this purpose, that part of the roof which lies in the direction of the meridian, in particular, should have moveable covers, which may easily be moved, by which means an instrument may be directed to any point of the heavens between the horizon and the zenith, as well to the northward as southward. This place, called an observatory, should contain the following instruments:

I. *A Pendulum Clock*, for showing equal time. This should show time in hours, minutes, and seconds: the observer, by hearing the beats of the pendulum, may count them by his ear, while his eye is employed on the motion of the celestial object he is observing. Just before the object arrives at the position described, the observer should look on the clock and remark the time, suppose it 9 hours, 15 minutes, 25 seconds; then saying, 25, 26, 27, 28, &c. responsive to the beat of the pendulum, till he sees through the instrument the object arrived at the position expected; which suppose to happen when he says thirty-eight, he then writes down 9h 15′ 38″ for the time of observation, annexing the particular day. If two persons are concerned in making the observation, one may read the time audibly while the other observes through the instrument, the observer repeating the last second read when the desired position happens.

II. *An Achromatic Refracting Telescope*, or a reflecting one of two feet at least in length, for observing particular phenomena. See TELESCOPE.

III. *A Micrometer* for measuring small angular distances. See MICROMETER.

IV. *A Quadrant*, for a description of which, and its several uses, we refer to the article QUADRANT. We may, however, observe, that besides Hadley's quadrant, which is described there, we have the mural quadrant, which is reckoned one of the most useful and valuable of all the astronomical instruments, and is generally fixed to the side of a stone or brick wall, and the plane of it is erected exactly in the plane of the meridian. There is also a portable astronomical quadrant, which is in high estimation, on account of its being capable of being carried to any part of the world, and put

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NICERON.

NICERON (John Francis,) in biography, a French monk and ingenious mathematician in the seventeenth century, was born at Paris, in the year 1613. He early displayed a love of learning, and by the progress which he made in his elementary studies, afforded fair promise of future excellence. At the age of nineteen he entered into the order of Minims, and before he had gone through his course of philosophy, discovered that his predominant inclination was to the study of mathematical sciences, to which, after he had completed his theological course, he devoted all the time that was not necessarily occupied by the duties of his profession. The science of optics was what principally engaged his attention; and he left behind him, in different houses belonging to his order, particularly that at Paris, some excellent performances, which afforded satisfactory evidence of his profound skill in this branch of the mathematics. He was twice sent on business to Rome, and was appointed regent of the philosophical classes. Afterwards he was nominated to accompany father Francis de la Noue, vicar-general of the order, in his visitation of all the convents of Minims in France. The similarity of their taste proved the means of introducing him to the acquaintance of Des Cartes, who entertained a great regard for him, and made him a present of his "Principles of Philosophy." Their intimacy, however, which commenced in 1644, proved but of short duration, since our young monk fell sick at Aix, in Provence, and died there in the autumn of 1646, when he was only thirty-three years of age. This event was lamented as a considerable loss to the republic of letters. He was the author of the following works, which are held in high estimation. "The Interpretation of Cyphers, or, a Rule for the perfect Understanding and certain explanation of all Kinds of simple Cyphers, taken from the Italian of the Sieur Anthony Maria Cospi, secretary to the Grand Duke of Tuscany; enlarged, and particularly accommodated to the French and Spanish Languages," 1641, octavo; "Curious Perspective, or artificial Magic, produced by the wonderful Effects of Optics, Catoptrics, and Dioptrics," &c. 1638, folio; which was only introductory to his "Thaumaturgus Opticus, sive, admirandæ Optices, Catoptrices, et Dioptrices, Pars prima, de iis quæ spectant ad visionem directam," 1646, folio. On this work he was employed six years, and was prevented by his death from proceeding to the completion of the intended second and third parts, relating to the effects of reflection from plane, cylindrical, and conical mirrors, and the refraction of crystals. This task his friend father Mersenne undertook, not only by correcting what Niceron's papers in Latin and French would furnish towards it, but by supplying what might be necessary to perfect it. But the other occupations of this learned mathematician, during the two remaining years of his own life, prevented him from

finishing the work, which, upon his death, was committed for that purpose to M. de Roberval, professor royal of mathematics at Paris. A "Letter" of Father Niceron's is inserted in the third volume of Liceto's "De quæsitis per Epistolas."

NICHE, in architecture, a concave recess in a wall having a semi-circular or elliptical head, intended to contain a statue or bust.

NICKEL. A white metal, which, when obtained pure, is both ductile and malleable. It may be forged into very thin plates, their thickness not being greater than 0.01 of an inch. Its colour is intermediate between that of silver and tin, and is not altered by the air. It is nearly as hard as iron. Its specific gravity is 8.279, and when forged 8.666.

The species of nickel ores are, its alloy with arsenic, and a little sulphur and its oxide.

The first is the most abundant, and the one from which nickel is usually extracted. It is known to mineralogists by the name of kupfer-nickel, or copper-nickel, from its colour and appearance. It occurs generally massive and disseminated; its colour is copper-red of various shades; its lustre is weakly, shining, and metallic; it is perfectly opaque; its fracture is uneven; it is hard, has no malleability, but is not easily broken; its specific gravity is from 6.6 to 7.5. Urged by the flame of the blow-pipe, it gives vapours with a strong arsenical odour, and melts with difficulty. It dissolves in acids, giving a green solution. Bergman found it to be composed of nickel, iron, cobalt, arsenic, and sulphur. Vauquelin regards it as essentially an alloy of nickel and arsenic, the iron, cobalt, and sulphur, being accidental.

The other species, the oxide of nickel, occurs generally as an incrustation, sometimes also disseminated, of a friable texture and earthy appearance; of an apple green colour, without lustre. It is not altered by the heat of the blow-pipe; but when mixed with borax gives to it a yellowish red colour. Its solution in acids is of a green colour. It occurs generally with kupfer-nickel, or with certain cobalt ores. It is also contained in small quantities in a fossil of the siliceous genus, chrysoprase, to which it communicates an apple-green colour.

Nickel is extracted from the kupfer-nickel, but it is extremely difficult to free it entirely from the metals with which it is associated. The process given by Chenevix is the most simple. The metal obtained from kupfer-nickel, by roasting and fusion with three times its own weight of black flux, is dissolved in nitric acid, the solution being boiled, so that the arsenic present receiving oxygen from the acid may be converted into arsenic acid; a solution of nitrate of lead is then dropped in, and the liquor evaporated by a very gentle heat, but not quite to dryness. Alcohol poured into this solution precipitates every salt, but the nitrate of nickel, which has been formed by the double decomposition of the arseniate of nickel and the nitrate of lead. The alcohol of the solution of nitrate of nickel being evaporated, the metallic salt is redissolved in water and decomposed by potash. The oxide, well washed and dried, is reduced in an Hessian crucible lined with lamp-black.

By the experiments that have been made on nickel in its pure state, it appears to be proved that it is possessed of magnetic power, and that therefore iron is not the only metal to which it belongs. The magnetic properties of nickel had often been observed; but as, in the usual processes by which it is obtained, it is always alloyed with iron, it was concluded, with probability, that the magnetism it exhibited was owing to the presence of that metal. Since methods, however, have since been discovered of obtaining nickel in a purer state, the error of this conclusion has been discovered. The effect of the magnet on it is very little inferior to that which it exerts on iron; and the metal itself becomes magnetic itself by friction with a magnet, or even by beating with a hammer. Magnetic needles have even been constructed of it in France, and have been preferred to those of steel, as resisting better the action of the air. The nickel preserves its magnetic property when alloyed with copper, though it is somewhat diminished; by a small portion of arsenic it is completely destroyed.

Nickel is extremely fusible; its fusing point being higher than that of iron.

This metal is oxyded by exposure to the atmospheric air at a high temperature, though with difficulty. Its oxide is more easily obtained by exposure to heat with nitre; it is of an apple green colour, and is obtained likewise of this colour by precipitation from some of its saline combinations. It appears to be the oxide at the minimum of oxydement; at least, according to the experiments of Thenard, another oxide can be formed more high-

ly oxyded. It may be obtained by exposing the green oxide to a red heat, or by heating it with oxymuriatic acid. It appears, therefore, to be too highly oxydized to be capable of directly combining with any of the acids. According to Richter, oxide of nickel is reduced by heat alone; and the only difficulty experienced is the intensity of the heat required to fuse the metal.

Nickel is oxydized and dissolved by a number of acids; its solutions being generally of a green colour and crystallizable.

The salts of nickel are decomposed by the alkalies, and the oxide, more or less free from the acid, is thrown down. If the alkalies are added in excess, they redissolve it; and with ammonia, in particular, soluble triple salts are formed. Potash and soda dissolve even a small quantity of its pure oxide; ammonia dissolves it in a much larger quantity.

Nickel combines with sulphur by fusion. The compound has a yellow colour with some brilliancy. It is brittle and hard, and burns when strongly heated in contact with the air. Nickel is also dissolved by the alkaline sulphurets.

With phosphorus, nickel unites, either by projecting the phosphorus on the nickel at a high temperature, or by heating together phosphoric acid and nickel with a little charcoal. The nickel increases in weight one-fifth. The compound is of a white colour with metallic lustre, and appears composed of a congeries of prisms.

Nickel forms alloys with a number of the metals; but our knowledge of these combinations is very imperfect.

NICOTIANA, in botany, *tobacco*, a genus of the Pentandria Monogynia class and order. Natural order of Luridæ. Solaneæ, Jussieu. Essential character: corolla funnel form, with a plaited border; stamina inclined; capsule two-valved, two-celled. There are seven species, of which N. rustica, English tobacco, seldom rises more than three feet in height, having smooth alternate leaves upon short foot stalks; flowers in small loose bunches on the top of the stalks, of a yellow colour, appearing in July, which are succeeded by roundish capsules, ripening in the autumn. Sir Walter Raleigh, on his return from America, is said to have first introduced the smoking of tobacco into England. In the house in which he lived at Islington, are his arms, with a tobacco plant on the top of the shield. It is remarkable, that tobacco has prevailed over the original name, petum, in all the European languages, with very little variation, and even in Tartary and Japan. Tobacco is derived from the island Tobago. Petum is the Brasilian name.

NICTITATING *membrane*, in comparative anatomy, a thin membrane, chiefly found in the bird and fish-kind, which covers the eyes of these animals, sheltering them from the dust, or from too much light; yet is so thin and pellucid, that they can see pretty well through it.

NIDUS, among naturalists, signifies a nest, or proper repository for the eggs of birds, insects, &c. wherein the young of these animals are hatched and nursed.

NIEUWENTYT, (Bernard), in biography, a celebrated Dutch philosopher and mathematician, in the seventeenth and early part of the eighteenth century, was the son of a minister of Westgraafdyk, in North Holland, where he was born in the year 1654. He afforded early indications of a good genius, and a love of learning, which his father took care to encourage, by giving him the advantages of an excellent education. He was desirous of becoming acquainted with all the branches of knowledge; but he had the prudence and sagacity to proceed gradually in his acquirements, and to make himself master of one science, before he directed his attention to another. It was his father's wish, that he should be educated to his own profession; but when he found that his son was disinclined to such a destination, he very properly suffered him to follow the bent of his own genius. The first science to which young Nieuwentyt particularly directed his study, was logic, in order to fix his imagination, to form his judgment, and to acquire a habit of right reasoning; and in this science he grounded himself upon the principles of Des Cartes, with whose philosophy he was greatly delighted. In the next place, he engaged in the study of the mathematics, with the various departments of which he became intimately conversant.

He then entered upon the study of medicine, and the branches of knowledge more immediately connected with that science; and he afterward went through a course of reading on jurisprudence. In the study of all these sciences he succeeded so well, as deservedly to acquire the character of a good philosopher, a good mathematician, and an able just magistrate. From his writings it also appears, that he did not permit his various subjects of inquiry to divert his thoughts from a due attention to the great and fundamental principles of natural and revealed reli-

gion. He was naturally of a grave and serious disposition; but at the same time a very affable and agreeable companion. So engaging were his manners, that they conciliated the esteem of all his acquaintance; by which means he frequently drew over to his opinion, those who differed widely from him in sentiment. With such a character, he acquired great credit and influence in the council of the town of Puremerende, where he resided; and also in the states of that province, who respected him the more, because he never engaged in any cabals or factions, but recommended himself only by an open, manly, and upright behaviour. Had he aspired after some of the higher offices of government, there is no doubt but that his merits would have secured to him the suffrages of his countrymen; yet he preferred to such honours the cultivation of the sciences, contenting himself with being counsellor and burgomaster, without courting or accepting any other posts, which might interfere with his studies. He died in 1718, at the age of 63, having been twice married. He was the author of various works, among which are, "Considerationes circa Analyseos ad quantitates Infinite parvas applicatæ Principia, &c." 1694, octavo; in which he proposed some difficulties on the subject of the analysis of infinitessimals. "Analysis Infinitorum, seu Curvilineorum proprietates, ex Polygonorum deductæ," 1696, quarto; which is a sequel to the former, with attempts to remove those difficulties. "Considerationes Secundæ circa Calculi Differentialis Principiæ, et Responsio ad Virum nobilissimum G. G. Leibnitium,&c.' 1696, quarto; occasioned by an attack of Leibnitz on the author's "Analysis," in the Leipsic Journal for 1695. "A Treatise on the new Use of the Tables of Sines and Tangents," 1714. "The proper Use of the Contemplation of the Universe, for the Conviction of Atheists and Unbelievers," 1715, quarto; of which a French translation was published at Paris, in 1725, quarto, entitled, "L'Existence de Dieu demontrée par les Merveilles de la Nature;" and also an English one at London, in 1716, in three volumes, octavo, under the title of "The Religious Philosopher, or, the right Use of contemplating the Works of the Creator." A Memoir inserted in a Dutch Journal, entitled, "Bibliothéque de l'Europe," for the year 1716, in defence of the preceding work against a criticism of M. Bernard, in the "Nouvelles de la Republique des Lettres." "A Letter to M. Bothnia de Burmania, on his Article concerning Meteors," inserted in the "Nouvelles litter. du 22 Avril, 1719:" and about a month before his death, he put the finishing hand to an excellent refutation of Spinoza, which was published in Dutch at Amsterdam, in 1720, quarto.

NIGELLA, in botany, *fennel flower*, a genus of the Polyandria Pentagynia class and order. Natural order of Multisilique. Ranunculaceæ, Jussieu. Essential character: calyx none; petals five; nectary five, two-lipped, within the corolla; capsule as many, connected. There are five species; these are annual herbaceous plants, with pinnate or bipinnate leaves, and linear leaflets; flowers terminating, in some species surrounded with a five-leaved calyx like multifid involucre.

NIGHT, that part of the natural day during which the sun is underneath the horizon; or that space wherein it is dusky. Night was originally divided by the Hebrews, and other eastern nations, into three parts, or watchings. The Romans, and afterwards the Jews from them, divided the night into four parts, or watches, the first of which began at sun-set and lasted till nine at night, according to our way of reckoning; the second lasted till midnight; the third till three in the morning; and the fourth ended at sun-rise.—The ancient Gauls and Germans divided their time not by days but by nights; and the people of Iceland and the Arabs do the same at this day. The like is also observed of our Saxon ancestors.

NIGHTINGALE. See MOTACILLA.

NIGRINE, in mineralogy, a species of the Menachine genus. Colour, dark brownish-black, passing to velvet black; it occurs in larger and smaller angular grains; specific gravity 4.5. It is not attracted by the magnet; it is infusible *per se*, but with borax it melts to a transparent hyacinth-red globule; it yields its menachine to acid of sugar. This species is found in Transylvania, consisting of yellow sand, intermixed with fragments of granite, gneiss, and mica-slate, and from which gold is obtained by washing. It comes to us commonly intermixed with grains of precious garnet, cyanite, and common sand. Its name is derived from its black colour; it is distinguished from menachanite by its stronger lustre, superior hardness, the colour of the streak, as well as by its not being in the smallest degree affected by the magnet, which also distinguishes it from iron-sand. Its constituent parts are,

Oxide of menachine	84
Oxide of iron	14
Oxide of manganese	2
	100

NILOMETER, sometimes called *Niloscope*, an instrument used among the ancients to measure the height of the water in the river Nile, in its periodical oveflowings. It was first set up, it has been asserted, by Joseph, during his government in Egypt. The measure of it was sixteen cubits, this being the height to which it must rise in order to insure the fruitfulness of the country.

NINTH, in music, an interval containing an octave and a tone; also a name given to the chord consisting of a common chord with the eighth advanced one note.

NIPA, in botany, a genus of the Appendix Palmæ class. Natural order of Palmæ or Palms. Essential character: male, spathe; corolla six-petalled: female, spathe; corolla, none; drupes angular. There is but one species, *viz.* N. fruticans, the young palm, is without the trunk; but in the adult state, it is some feet in height; leaves pinnate; pinnastriated, margined, and smooth; flowers male and female on the same palm; but distinct on different peduncles: males several, lateral, inferior, on dichotomous peduncles, in spikes: females terminating, aggregate in a globular head, sessile. It is a native of Java and other islands in the East Indies, where the leaves are used for covering houses and making mats. The fruit is eaten both raw and preserved.

NIPPLES, in anatomy. See MAMMARY *gland.*

NISI PRIUS, a commission directed to the judges of assize, empowering them to try all questions of fact issuing out of the courts at Westminster, that are then ready for trial by jury. The original of which name is this: all causes commenced in the courts of Westminster-hall, are, by course of the courts, appointed to be tried on a day fixed in some Easter or Michaelmas term, by a jury returned from the county where the cause of action arises; but with this proviso, *nisi prius justiciarii ad assisas capiendas venerint*: that is, unless before the day prefixed, the judges of assize came into the county in question, which they always do in the vacation preceding each Easter and Michaelmas term, and there try the cause; and then, upon the return of the verdict given by the jury to the court above, the judges there give judgment for the party for whom the verdict is found. All trials at law, in the civil courts, and at the assizes, are tried by this process, and are called trials at nisi prius.

NISSOLIA, in botany, so named in honour of Guill. Nissole, M. D. of Montpellier; a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx five-toothed; capsule one-seeded, ending in a ligulate wing. There are two species, *viz.* N. arborea, tree nissolia; and N. fruticosa, shrubby nissolia; both natives of Carthagena, in woods and coppices.

NITIDULA, in natural history, a genus of insects of the order Coleoptera. Antennæ clavate, the club solid, and nearly orbicular; shells margined; head prominent; thorax flattened, margined. There are about forty-two species enumerated by Gmelin, separated into sections according to the form of the lip. A. Lip cylindrical. B. Lip square. N. bipustulata, is oval, black; shells with a red dot. It inhabits Europe and America, and lives on carcases, meat, bacon, &c.

NITRARIA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Ficoideæ, Jussieu. Essential character: calyx five-cleft; corolla five-petalled, with the petals arched at top; stamina fifteen or more; drupe one-seeded. There is but one species, *viz.* N. schoberi. Thick-leaved Nitraria.

NITRATES, in chemistry, salts formed of the nitric acid, and alkalies, earths, &c. They possess the following properties: soluble in water, and capable of crystallizing by cooling; when heated to redness with combustible bodies, a violent combustion and detonation is produced: sulphuric acid disengages from them fumes which have the odour of nitric acid: when heated with muriatic acid, oxymuriatic acid is driven off: they are decomposed by heat, and yield at first oxygen gas. There are twelve nitrates, of which the most important is the nitrate of potash, or nitre; this salt, known also by the name of salt-petre, is produced naturally in considerable quantities, particularly in Egypt, and has been known from time immemorial. Roger Bacon mentions it under the name of nitre, in the thirteenth century. The importance of this substance for the purposes of war, has led chemists to seek the best means of preparing it, especial-

ly as nature has not laid up large magazines of it, as she has of other salts. It is now ascertained, that nothing more is necessary for the production of nitre than a basis of lime, heat, and an open, but not too free communication with dry atmospheric air. When these circumstances combine, the acid is first formed, and afterwards the alkali. See Nitric *acid*.

NITRE. See Nitrates. Nitre is found abundantly on the surface of the earth, in India, South America, South Africa, and even in some parts of Spain. In Germany and France it is obtained by means of artificial nitre-beds. These consist of the refuse of animal and vegetable bodies, undergoing putrefaction, mixed with calcareous and other earths. It has been ascertained, that if oxygen gas be presented to azote at the instant of its disengagement, nitric acid is formed. This seems to explain the origin of the acid in these beds. The azote, disengaged from these putrifying animal substances, combines with the oxygen of the air. The potash is probably furnished, partly at least, by the vegetables and the soil. The nitre is extracted from these beds, by lixiviating the earthy matters with water. This water, when sufficiently impregnated, is evaporated, and a brown-coloured salt obtained, known by the name of crude nitre. It consists of nitre, common salt, nitrate of lime, and various other salts. The foreign salts are either separated by repeated crystallizations, or by washing the salt repeatedly with small quantities of water: for the foreign salts being more soluble, are taken up first. Nitre, when slowly evaporated, is obtained in six-sided prisms, terminated by six-sided pyramids; but for most purposes, it is preferred in an irregular mass, because in that state it contains less water. The specific gravity of nitre, as ascertained by Dr. Watson, is 1.9. Its taste is sharp, bitterish, and cooling. It is very brittle. It is soluble in seven times its weight of water, at the temperature of 60°; and in rather less than its own weight of boiling water. When exposed to a strong heat it melts, and congeals by cooling into an opaque mass, which has been called mineral crystal. Whenever it melts, it begins to disengage oxygen; and, by keeping it in a red heat, about a third of its weight of that gas may be obtained: towards the end of the process azotic gas is disengaged. If the heat be continued long enough; the salt is completely decomposed, and pure potash remains behind. It detonates more violently with combustible bodies than any of the other nitrates. When mixed with one-third part of its weight of charcoal, and thrown into a red-hot crucible, or when charcoal is thrown into red-hot nitre, detonation takes place, and one of the most brilliant combustions that can be exhibited. The residuum is carbonate of potash. A still more violent detonation takes place, if phosphorus is used instead of charcoal. Nitre oxydizes all the metals at a red heat. The composition of nitre, according to Kirwan, is

Acid	.44
Potash	51.8
Water	4.2
	100.0

Nitre furnishes all the nitric acid in all its states, employed either by chemists or artists: it is obtained by decomposing it by means of the sulphuric acid. When burnt with tartar, it yields a pure carbonate of potash. In the assaying of various ores it is indispensable, and is equally necessary in the analysis of many vegetable and animal substances. But one of the most important compounds, formed by means of nitre, is gunpowder, which has completely changed the modern art of war. The discoverer of this compound, and the person who first thought of applying it to the purposes of war, are unknown. It is certain, however, that it was used in the fourteenth century. From certain archives, quoted by Wiegleb, it appears that cannons were employed in Germany before the year 1372. No traces of it can be found in any European author, previous to the thirteenth century; but it seems to have been known to the Chinese long before that period. There is reason to believe, that cannons were used in the battle of Cressy, which was fought in 1346. They seem even to have been used three years earlier at the siege of Algesiras; but before this time, they must have been known in Germany, as there is a piece of ordnance at Amberg, on which is inscribed the year 1303. Roger Bacon, who died in 1292, knew the properties of gunpowder; but it does not follow that he was acquainted with its application to fire-arms. See Gunpowder. When three parts of nitre, two parts of potash, and one part of sulphur, all previously well dried, are mixed together in a warm mortar, the resulting compound is known by the name of fulminating powder. If a little of this powder be

put into an iron spoon, and placed upon burning coals, or held above the flame of a candle, it gradually blackens, and at last melts. At that instant it explodes with a very violent report, and a strong impression is made upon the bottom of the spoon, as if it had been pressed down very violently. This sudden and violent combustion is occasioned by the rapid action of the sulphur on the nitre. By the application of the heat, the sulphur and potash form a sulphuret, which is combustible at a lower heat probably than even sulphur. Sulphurated hydrogen gas, azotic gas, and perhaps also sulphurous acid gas, are disengaged almost instantaneously. It is to the sudden action of these on the surrounding air that the report is to be ascribed. Its loudness evidently depends upon the combustion of the whole powder at the same instant, which is secured by the previous fusion that it undergoes; whereas the grains of gunpowder burn in succession. A mixture of equal parts of tartar and nitre, deflagrated in a crucible, is known by the name of white flux. It is merely a mixture of carbonate of potash, with some pure potash. When two parts of tartar, and one of nitre, are deflagrated in this manner, the residuum is called black flux, from its colour. It is merely a mixture of charcoal and carbonate of potash.

Nitre is much used in medicine, in fevers as a cooling remedy, and as a diuretic in urinary affections. It is employed also in many arts, as in dying; and in domestic economy, for the preservation of animal substances used for food. To these substances it imparts a red colour. See Nitrous *acid;* also Gunpowder.

NITRIC *acid.* The two principal constituent parts of our atmosphere, when in certain proportions, are capable, under particular circumstances, of combining chemically, into one of the most powerful acids, the nitric, which consists, according to Mr. Davy, of 70.5 of oxygen, and 29.5 of azote, or nitrogen. If these gases be mixed in this proportion in a glass tube, about a line in diameter, over mercury, and a series of electric shocks be passed through them for some hours, they will form nitric acid; or, if a solution of potash be present with them, nitrate of potash will be obtained. The constitution of this acid may be further proved, analytically, by driving it through a red-hot porcelain tube, as thus it will be decomposed into oxygen and nitrogen gases. For all practical purposes, however, the nitric acid is obtained from nitrate of potash, from which it is expelled by sulphuric acid.

Four parts of pure nitrate of potash, coarsely powdered, are to be put into a glass retort, and three parts of concentrated sulphuric acid cautiously added, taking care to avoid the fumes that arise, which is best done by standing in a current of air, to convey them up the chimney. Join to the retort a tubulated receiver of large capacity, with an adopter interposed, and lute the junctures with a mixture of pipe-clay, sifted sand, and cut tow. In the tubulure fix with fat lute a glass tube terminating in another large receiver, in which is a small quantity of water; and, if you wish to collect the gaseous products, let a bent glass tube from this receiver communicate with a pneumatic trough. Apply heat to the receiver by means of a sand bath. The first product that passes into the receiver is generally red and fuming; but the appearances gradually diminish, till the acid comes over pale, and even colourless, if the materials used were clean. After this it again becomes more and more red and fuming, till the end of the operation; and the whole mingled together will be of a yellow or orange colour.

In the large way, and for the purposes of the arts, extremely thick cast iron or earthen retorts are usually employed, to which an earthen head is adapted, and connected with a range of proper condensers. The strength of the acid too is varied, by putting more or less water in the receivers. The nitric acid thus made generally contains sulphuric acid, and also muriatic, from the impurity of the nitrate employed. If the former, a solution of nitrate of barytes will occasion a white precipitate: if the latter, nitrate of silver will render it milky. The sulphuric acid may be separated by a second distillation from very pure nitre, equal in weight to an eighth of that originally employed; or by precipitating with nitrate of barytes, decanting the clear liquid, and distilling it. The muriatic acid may be separated by proceeding in the same way with nitrate of silver, or with litharge, decanting the clear liquor, and redistilling it, leaving an eighth or tenth part in the retort. The acid for the last process should be condensed as much as possible, and the redistillation conducted very slowly; and if it be stopped when half is come over, beautiful crystals of muriate of lead will be obtained on cooling the remainder, if litharge be used, as M. Steinacher informs us; who also adds, that the vessels should

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be made to fit tight by grinding, as any lute is liable to contaminate the product.

As this acid still holds in solution more or less nitrous gas, it is not, in fact, nitric acid, but a kind of nitrous: it is therefore necessary to put it into a retort, to which a receiver is added, the two vessels not being luted, but merely joined by paper; and to apply a very gentle heat for several hours, changing the receiver as soon as it is filled with red vapours. The nitrous gas will thus be expelled, and the nitric acid will remain in the retort, as limpid and colourless as water. It should be kept in a bottle secluded from the light, otherwise it will lose part of its oxygen.

The strongest acid that Mr. Kirwan could procure at 60° was 1.5543, which by his calculation contained .7354 of real acid; but Rouelle professes to have obtained it of 1.583. It is observable, that, on comparing the tables of Kirwan and Davy, the aëriform acid appears to contain a considerable portion of water more than that which is combined with soda to form the nitrate.

Nitric acid should be of the specific gravity of 1.5, or a little more, and colourless. It boils at 248°, and may be distilled without any essential alteration. Exposed to the air it absorbs moisture. If two parts be suddenly diluted with one of water, the temperature will rise to about 112°; but the addition of more water to this diluted acid will lower its temperature. It retains its oxygen with little force, so that it is decomposed by all combustible bodies. Brought into contact with hrydogen gas at a high temperature, a violent detonation ensues, so that this must not be done without great caution. It inflames volatile oils, such as those of turpentine and cloves, when suddenly poured on them: but, to perform this experiment with safety, the acid must be poured out of a bottle tied to the end of a long stick, otherwise the operator's face and eyes will be greatly endangered. If it be poured on perfectly dry charcoal powder, it excites combustion, with the emission of copious fumes. By boiling it with sulphur it is decomposed, and its oxygen, uniting with the sulphur, forms sulphuric acid. Chemists in general agree, that it acts very powerfully on almost all the metals: but Baumé has asserted, that it will not dissolve tin; and Dr. Woodhouse of Pennsylvania affirms, that in a highly concentrated and pure state it acts not at all on silver, copper, or tin, though with the addition of a little water its action on them is very powerful. He does not mention the specific gravity of this acid: he only says, that it was prepared by first expelling the water of crystallization from nitre by heat, and then decomposing this nitre by means of strong sulphuric acid.

The nitric acid is of considerable use in the arts. It is employed for etching on copper; as a solvent of tin to form with that metal a mordant for some of the finest dyes; in metallurgy and assaying; in various chemical processes, on account of the facility with which it parts with oxygen and dissolves metals; in medicine as a tonic, and as a substitute for mercurial preparations in siphylis and affections of the liver; as also in the form of vapour, to destroy contagion. For the purposes of the arts it is commonly used in a diluted state, and contaminated with the sulphuric and muriatic acids, by the name of aqua fortis. This is generally prepared by mixing common nitre with an equal weight of sulphate of iron, and half its weight of the same sulphate calcined, and distilling the mixture: or by mixing nitre with twice its weight of dry powdered clay, and distilling in a reverberatory furnace. Two kinds are found in the shops, one called double aqua fortis, which is about half the strength of nitric acid; the other simply aqua fortis, which is half the strength of the double.

A compound made by mixing two parts of the nitric acid with one of muriatic, known formerly by the name of aqua regia, and now by that of nitro-muriatic acid, has the property of dissolving gold and platina. On mixing the two acids, heat is given out, an effervescence takes place, oxygenated muriatic acid gas is evolved, and the mixture acquires an orange colour. This is likewise made by adding gradually to an ounce of powdered muriate of ammonia, four ounces of double aqua fortis, and keeping the mixture in a sand-heat till the salt is dissolved; taking care to avoid the fumes, as the vessel must be left open: or by distilling nitric acid with an equal weight, or rather more, of common salt.

With the different bases the nitric acid forms nitrates.

The nitrate of barytes, when perfectly pure, is in regular octaëdral crystals, though it is sometimes obtained in small shining scales. It may be prepared by uniting barytes directly with nitric acid, or by decomposing the carbonate of sulphuret of barytes with this acid. Exposed to heat it decrepitates, and at length gives out its acid, which is decomposed;

but if the heat be urged too far, the barytes is apt to vitrify with the earth of the crucible. It is soluble in 12 parts of cold, and 3 or 4 of boiling water. It is said to exist in some mineral waters.

The nitrate of potash is the salt well known by the name of nitre, or saltpetre. It is found ready formed in the East Indies, in Spain, in the kingdom of Naples, and elsewhere, in considerable quantities; but nitrate of lime is still more abundant. Far the greater part of the nitrate made use of is produced by a combination of circumstances which tend to compose and condense nitric acid. This acid appears to be produced in all situations, where animal matters are completely decomposed with access of air, and of proper substances with which it can readily combine. Grounds frequently trodden by cattle, and impregnated with their excrements, or the walls of inhabited places where putrid animal vapours abound, such as slaughter-houses, drains, or the like, afford nitre by long exposure to the air. Artificial nitre beds are made by an attention to the circumstances in which this salt is produced by nature. Dry ditches are dug, and covered with sheds, open at the sides, to keep off the rain: these are filled with animal substances, such as dung, or other excrements, with the remains of vegetables, and old mortar, or other loose calcareous earth; this substance being found to be the best and most convenient receptacle for the acid to combine with. Occasional watering, and turning up from time to time, are necessary, to accelerate the process, and increase the surfaces to which the air may apply; but too much moisture is hurtful. When a certain portion of nitrate is formed, the process appears to go on more quickly: but a certain quantity stops it altogether, and after this cessation the materials will go on to furnish more, if what is formed be extracted by lixiviation. After a succession of many months, more or less, according to the management of the operation, in which the action of a regular current of fresh air is of the greatest importance, nitre is found in the mass. If the beds contained much vegetable matter, a considerable portion of the nitrous salt will be common saltpetre; but, if otherwise, the acid will, for the most part, be combined with the calcareous earth.

To extract the saltpetre from the mass of earthy matter, a number of large casks are prepared, with a cock at the bottom of each, and a quantity of straw within, to prevent its being stopped up. Into these the matter is put, together with wood-ashes, either strewed at top, or added during the filling. Boiling water is then poured on, and suffered to stand for some time; after which it is drawn off, and other water added in the same manner, as long as any saline matter can be thus extracted. The weak brine is heated, and passed through other tubs, until it becomes of considerable strength. It is then carried to the boiler, and contains nitre and other salts; the chief of which is common culinary salt, and sometimes muriate of magnesia.

It is the property of nitre to be much more soluble in hot than cold water; but common salt is very nearly as soluble in cold as in hot water. Whenever, therefore, the evaporation is carried by boiling to a certain point, much of the common salt will fall to the bottom, for want of water to hold it in solution, though the nitre will remain suspended by virtue of the heat. The common salt thus separated is taken out with a perforated ladle, and a small quantity of the fluid is cooled, from time to time, that its concentration may be known by the nitre which crystallizes in it. When the fluid is sufficiently evaporated, it is taken out and cooled, and great part of the nitre separates in crystal; while the remaining common salt continues dissolved, because equally soluble in cold and in hot water. Subsequent evaporation of the residue will separate more nitre in the same manner.

This nitre, which is called nitre of the first boiling, contains some common salt; from which it may be purified by solution in a small quantity of water, and subsequent evaporation: for the crystals thus obtained are much less contaminated with common salt than before; because the proportion of water is so much larger with respect to the small quantity contained by the nitre, that very little of it will crystallize. For nice purposes, the solution and crystallization of nitre are repeated four times. The crystals of nitre are usually of the form of six-sided flattened prisms, with diedral summits. Its taste is penetrating; but the cold produced, by placing the salt to dissolve in the mouth, is such as to predominate over the real taste at first. Seven parts of water dissolve two of nitre, at the temperature of sixty degrees: but boiling water dissolves its own weight. One hundred parts of alcohol, at a heat of one

hundred and seventy-six degrees, dissolve only 2.9.

On being exposed to a gentle heat, nitre fuses; and in this state being poured into moulds, so as to form little round cakes, or balls, it is called sal prunella, or crystal mineral. This at least is the way in which this salt is now usually prepared, conformably to the directions of Boerhaave; though in most dispensatories a twenty-fourth part of sulphur was directed to be deflagrated on the nitre, before it was poured out. This salt should not be left on the fire after it has entered into fusion, otherwise it will be converted into a nitrite of potash. If the heat be increased to redness, the acid itself is decomposed, and a considerable quantity of tolerably pure oxygen gas is evolved, succeeded by nitrogen.

This salt powerfully promotes the combustion of inflammable substances. Two or three parts mixed with one of charcoal, and set on fire, burn rapidly; azote and carbonic acid gas are given out, and a small portion of the latter is retained by the alkaline residuum, which was formerly called clyssus of nitre. Three parts of nitre, two of subcarbonate of potash, and one of sulphur, mixed together in a warm mortar, form the fulminating powder; a small quantity of which, laid on a fire shovel, and held over the fire till it begins to melt, explodes with a loud sharp noise. Mixed with sulphur and charcoal, it forms gunpowder. See GUNPOWDER.

Three parts of nitre, one of sulphur, and one of fine saw-dust, well mixed, constitute what is called the powder of fusion. If a bit of base copper be folded up and covered with this powder in a walnut shell, and the powder be set on fire with a lighted paper, it will detonate rapidly, and fuse the metal into a globule of sulphuret, without burning the shell.

If nitrate of potash be heated in a retort, with half its weight of solid phosphoric or boracic acid, as soon as this acid begins to enter into fusion, it combines with the potash, and the nitric acid is expelled, accompanied with a small portion of oxygen gas and nitric oxide.

Silex, alumine, and barytes, decompose this salt in a high temperature by uniting with its base, as was observed when speaking of aqua fortis. The alumine will effect this even after it has been made into pottery.

The uses of nitre are various. Beside those already indicated, it enters into the composition of fluxes, and is extensively employed in metallurgy: it serves to promote the combustion of sulphur in fabricating its acid; it is used in the art of dying; it is added to common salt for preserving meat, to which it gives a red hue; it is an ingredient in some frigorific mixtures; and it is prescribed in medicine, as cooling, febrifuge, and diuretic, and some have recommended it mixed with vinegar as a very powerful remedy for the sea scurvy.

Nitrate of soda, formerly called cubic or quadrangular nitre, approaches in its properties the nitrate of potash; but differs from it in being somewhat more soluble in cold water, though less in hot, which takes up little more than its own weight; in being inclined to attract moisture from the atmosphere; and in crystallizing in rhombs, or rhomboidal prisms. It may be prepared by saturating soda with the nitric acid, by precipitating nitric solutions of the metals, or of the earths, except barytes, by soda: by lixiviating and crystallizing the residuum of common salt distilled with three-fourths its weight of nitric acid; or by saturating the mother waters of nitre with soda instead of potash.

This salt has been considered as useless; but professor Proust says, that five parts of it, with one of charcoal and one of sulphur, will burn three times as long as common powder, so as to form an œconomical composition for fireworks.

Nitrate of strontian may be obtained in the same manner as that of barytes, with which it agrees in the shape of its crystals, and most of its properties. It is much more soluble, however, requiring but four or five parts of water according to Vauquelin, and only an equal weight according to Mr. Henry. Boiling water dissolves nearly twice as much as cold. Applied to the wick of a candle, or added to burning alcohol, it gives a deep red colour to the flame. On this account it might be useful, perhaps, in the art of pyrotechny.

Nitrate of lime, the calcareous nitre of older writers, abounds in the mortar of old buildings, particularly those that have been much exposed to animal effluvia, or processes in which azote is set free. Hence it abounds in nitre beds, as was observed when treating of the nitrate of potash. It may also be prepared artificially, by pouring dilute nitric acid on carbonate of lime. If the solution be

boiled down to a syrupy consistence, and exposed in a cool place, it crystallizes in long prisms, resembling bundles of needles diverging from a centre. These are soluble, according to Henry, in an equal weight of boiling water, and twice their weight of cold; soon deliquesce on exposure to the air; and are decomposed at a red heat. Fourcroy says, that cold water dissolves four times its weight, and that its own water of crystallization is sufficient to dissolve it at a boiling heat. It is likewise soluble in less than its weight of alcohol. By evaporating the aqueous solution to dryness, continuing the heat till the nitrate fuses, keeping it in this state five or ten minutes, and then pouring it into an iron pot previously heated, we obtain Baldwin's phosphorus. This, which is, perhaps, more properly nitrite of lime, being broken to pieces, and kept in a phial closely stopped, will emit a beautiful white light in the dark, after having been exposed some time to the rays of the sun. At present no use is made of this salt, except for drying some of the gases by attracting their moisture; but it might be employed instead of the nitrate of potash for manufacturing aqua fortis.

The nitrate of ammonia possesses the property of exploding, and being totally decomposed, at the temperature of 600°: whence it acquired the name of nitrum flammans. The readiest mode of preparing it is, by adding carbonate of ammonia to dilute nitric acid till saturation takes place. If this solution be evaporated in a heat between 70° and 100°, and the evaporation not carried too far, it crystallizes in hexaëdral prisms terminating in very acute pyramids; if the heat rise to 212°, it will afford, on cooling, long fibrous silky crystals: if the evaporation be carried so far as for the salt to concrete immediately on a glass rod by cooling, it will form a compact mass. According to Mr. Davy, these differ but little from each other, except in the water they contain, their component parts being as follows:

	contains of acid	ammonia	water
Prismatic	69.5	18.4	12.1
Fibrous	72.5	19.3	8.2
Compact	74.5	19.8	5.7

All these are completely deliquescent, but they differ a little in solubility. Alcohol at 176° dissolves nearly 90.9 of its own weight.

The chief use of this salt is for affording nitrous oxide on being decomposed by heat. See nitrous oxide, under the art. GAS.

Nitrate of Magnesia, magnesian nitre, crystallizes in four-sided rhomboidal prisms, with oblique or truncated summits, and sometimes in bundles of small needles. Its taste is bitter, and very similar to that of nitrate of lime, but less pungent. It is fusible, and decomposable by heat, giving out first a little oxygen gas, then nitrous oxide, and lastly nitric acid. It deliquesces slowly. It is soluble in an equal weight of cold water, and in but little more hot, so that it is scarcely crystallizable but by spontaneous evaporation.

The two preceding species are capable of combining into a triple salt, an ammoniaco-magnesian nitrate, either by uniting the two in solution, or by a partial decomposition of either by means of the base of the other. This is slightly inflammable when suddenly heated: and by a lower heat is decomposed, giving out oxygen, azote, more water than it contained, nitrous oxide, and nitric acid. The residuum is pure magnesia. It is disposed to attract moisture from the air, but is much less deliquescent than either of the salts that compose it; and requires eleven parts of water at 60° to dissolve it. Boiling water takes up more, so that it will crystallize by cooling. It consists of 78 parts of nitrate of magnesia and 22 of nitrate of ammonia.

From the activity of the nitric acid as a solvent of earths in analyzation, the nitrate of glucine is better known than any other of the salts of this new earth. Its form is either pulverulent, or a tenacious or ductile mass. Its taste is at first saccharine, and afterward astringent. It grows soft by exposure to heat, soon melts, its acid is decomposed into oxygen and azote, and its base alone is left behind. It is very soluble and very deliquescent.

Nitrate, or rather supernitrate, of alumine, crystallizes, though with difficulty, in thin, soft, pliable flakes. It is of an austere and acid taste, and reddens blue vegetable colours. It may be formed by dissolving in diluted nitric acid, with the assistance of heat, fresh precipitated alumine, well washed but not dried. It is deliquescent, and soluble in a very small portion of water. Alcohol dissolves its

own weight. It is easily decomposed by heat.

Nitrate of zircone was first discovered by Klaproth, and has since been examined by Guyton-Morveau and Vauquelin. Its crystals are small, capillary, silky, needles. Its taste is astringent. It is easily decomposed by fire, very soluble in water, and deliquescent. It may be prepared by dissolving zircone in strong nitric acid; but, like the preceding species, the acid is always in excess.

Nitrate of ittria may be prepared in a similar manner. Its taste is sweetish, and astringent. It is scarcely to be obtained in crystals; and if it be evaporated by too strong a heat, the salt becomes soft like honey, and on cooling concretes into a stony mass. Exposed to the air it deliquesces.

NITRITES. Though these salts are composed of nitrous acid and certain bases, yet the only way of obtaining them is by exposing a nitrate to a pretty strong heat, till a quantity of the oxygen gas is disengaged from it: what remains is a nitrite. These salts have never been minutely examined; but it is inferred, from the experiments that have been made, that they are, in general, deliquescent, very soluble in water, decomposable by heat, and by exposure to the air they are gradually converted into nitrates by obsorbing oxygen.

NITROGEN. See ATMOSPHERE; also GAS.

NITROUS *acid.* It has already been observed, that there is no such thing, properly speaking, as nitrous acid, or the nitric base acidified with a minimum dose of oxygen; but that the nitric acid is capable of absorbing various portions of nitric oxide, with which it parts very readily, so that when in considerable quantity it gives it out in the ordinary state of the air, on mixing with which it assumes the appearance of a very red vapour. Hence it was formerly called fuming nitrous acid. It appears, however, to be capable of combining with some at least of the salifiable bases, so as to form a distinct genus of salts, that may be termed nitrites. But these cannot be formed by a direct union of their component parts; being obtainable only by exposing a nitrate to a high temperature, which expels a portion of its oxygen in the state of gas, and leaves the remainder in the state of a nitrite, if the heat be not urged so far, or continued so long, as to effect a complete decomposition of the salt. In this way the nitrates of potash and soda may be obtained, and perhaps those of barytes, strontian, lime, and magnesia. The nitrites are particularly characterized by being decomposable by all the acids except the carbonic, even by the nitric acid itself, all of which expel from it nitrous acid. We are little acquainted with any one except that of potash, which attracts moisture from the air, changes blue vegetable colours to green, is somewhat acrid to the taste, and when powdered emits a smell of nitric oxide.

NITROUS *oxide.* See GAS.

NOBILITY, a quality that ennobles and raises a person possessed of it above the rank of a commoner. The origin of nobility in Europe is by some referred to the Goths; who, after they had seized a part of Europe, rewarded their captains with titles of honour, to distinguish them from the common people. In Britain the term nobility is restrained to degrees of dignity above knighthood; but every where else nobility and gentility are the same. The British nobility consists only of five degrees, *viz.* that of a duke, marquis, earl or count, viscount, and baron, each of which see under their proper articles. In Britain these titles are only conferred by the King, and that by patent, in virtue of which it becomes hereditary. The privileges of the nobility are very considerable, they are all esteemed the King's hereditary counsellors, and are privileged from all arrests, unless for treason, felony, breach of peace, condemnation in parliament, and contempt of the king. They enjoy their seats in the House of Peers by descent, and no act of parliament can pass without their concurrence: they are the supreme court of judicature, and even in criminal cases give their verdict upon their honour, without being put to their oath. In their absence they are allowed a proxy to vote for them, and in all places of trust are permitted to constitute deputies, by reason of the necessity the law supposes them under of attending the King's person; but no peer is to go out of the kingdom without the King's leave, and when that is granted, he is to return with the King's writ, or forfeit goods and chattels.

NOBLE, a money of account, containing six shillings and eight-pence. The noble was anciently a real coin, struck in the reign of Edward III. and then called the penny of gold; but it was afterwards called a rose noble, from its being stamped with a rose.

NOCTURNAL, something relating to

the night, in contradistinction to diurnal.

Nocturnal *arch*, in astronomy, the arch of a circle described by the sun, or a star, in the night.

Nocturnal, *semi, arch of the sun*, is that portion of a circle he passes over between the lower part of our meridian and the point of the horizon, wherein he arises; or between the point of the horizon, wherein he sets, and the lower part of our meridian.

Nocturnal, or Nocturlabium, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night. Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole-star, and the pointers of the great bear.

This instrument consists of two circular plates applied to each other. The greater, which has a handle to hold the instrument, is about two inches and a half diameter, and is divided into twelve parts, agreeing to the twelve months, and each month subdivided into every fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth to be told in the night. Those at the hours twelve, are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, *viz*. the two circles and index, are joined by a rivet, which is pierced through the centre with a hole, through which the star is to be observed.

"To use the Nocturnal," turn the upper plate till the long tooth, marked twelve, be against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle, with the plane nearly parallel to the equinoctial; and viewing the pole-star through the hole of the centre, turn the index about till, by the edge coming from the centre, you see the bright star or guard of the little bear (if the instrument be fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour circle: which may be known without a light, by counting the teeth from the longest, which is for the hour twelve.

NODE, in surgery, a tumor arising on the bones, and usually proceeding from some venereal cause; being much the same with what is otherwise called exostosis.

NODES, in astronomy, the two points wherein the orbit of a planet intersects the ecliptic, whereof the node, where the planet ascends northwards, above the plane of the ecliptic, is called the ascending node, the northward node, and the head of the Dragon, and is marked thus ☊; the other node, where the planet descends to the south, is called the descending node, the southward node, or the Dragon's tail, marked thus ☋.

The line wherein the two circles intersect, is called the line of nodes. It appears from observation, that the line of the nodes of all the planets constantly changes its place, and shifts its situation from east to west, contrary to the order of the signs; and that the line of the Moon's nodes, by a retrogade motion, finishes its circulation in the compass of nineteen years; after which time, either of the nodes having receded from any point of the ecliptic, returns to the same again; and when the Moon is in the node, she is also seen in the ecliptic. If the line of nodes were immoveable, that is, if it had no other motion than that whereby it is carried round the Sun, it would always look to the same point of the ecliptic, or would keep parallel to itself, as the axis of the earth does.

From what has been said, it is evident that the Moon can never be observed precisely in the ecliptic but twice in every period; that is, when she enters the nodes. When she is at her greatest distance from the nodes, *viz*. in the points, she is said to be in her limits. The Moon must be in or near one of the nodes, when there is an eclipse of the Sun or Moon.

NOLANA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoleæ, or Luridæ. Borragineæ, Jussieu. Essential character: corolla bell-shaped; style among the germs; seeds five, berried, two-celled. There is but one species, *viz*. N. prostrata, trailing nolana.

NOLLE *prosequi*, is used where the plaintiff will proceed no further in his action, and may be as well before as after

a verdict, and is stronger against the plaintiff than a nonsuit, which is only a default in appearance; but this is a voluntary acknowledgment that he has no cause of action. In criminal cases it can only be entered by the Attorney General.

NOLLET (JOHN ANTHONY), in biography, a French ecclesiastic and celebrated natural philosopher in the eighteenth century, was born at Pimprè, in the diocese of Noyon, in the year 1700. His parents, who were persons of reputable character, though of humble fortunes, as they could not make him wealthy, determined to bestow on him the advantages of a good education. With this view they sent him to the college of Clermont in the Beauvoisin, and afterwards to Beauvais, where he laid a good foundation of grammar learning, which encouraged them to send him to Paris, in order to go through a course of philosophy at that university. It was their wish that he should embrace the ecclesiastical profession, and young Nollet adopted without repugnance the choice which they made for him. From a very early age he had shewn a taste for the study of natural philosophy, which had not yet become his ruling passion; he was, therefore, enabled to check himself in a pursuit which was likely to interfere with the studies more appropriate to his destined character, and gave himself up entirely to the study of scholastic theology. Having completed his academical course, and passed with reputation through the usual examinations, in 1728 he was admitted to deacon's orders, and soon became a licensed preacher. This new occupation, however, did not wholly divert his attention from the subjects of his early inquiries, and they insensibly claimed more and more of his time. At length his inclination for the sciences became irresistible, and he gave himself up to the study of natural philosophy, with an ardour to which the kind of privation in which he had so long lived gave augmented force. It was now his good fortune to become known to M. du Fay and M. Reaumur, and under their instructions his talents were rapidly developed. By the former he was received as an associate in his electrical researches; and the latter resigned to him his laboratory. He was also received into a Society of Arts, established at Paris under the protection of the Count de Clermont. In the year 1734, he accompanied M. M. du Fay, du Hamel, and de Jussieu, on a visit to England, where he had the honour of being admitted a foreign member of the Royal Society, and he profited so well of this visit, as to institute a friendly and literary correspondence with some of the most celebrated men in this country. Two years afterwards he made a tour to Holland, where he formed an intimate connection with s'Gravesande and Musschenbroek. Upon his return to Paris, he resumed a course of experimental philosophy, which he commenced in 1735, and which he continued to the year 1760. These courses of experimental physics gave rise to the adoption of similar plans in other branches of science, such as chemistry, anatomy, natural history, &c.

In the year 1738, the Count de Maurepas prevailed upon Cardinal Fleury to establish a public professorship of experimental philosophy at Paris, and the Abbé Nollet was the first person who received that appointment. During the following year, the Royal Academy of Sciences appointed him adjunct mechanician to that body; and in 1742 he was admitted an associate. In the year 1739, the King of Sardinia being desirous of establishing a professorship of physics at Turin, gave an invitation to the Abbé Nollet to perform a course of experimental philosophy before the royal family, with which he complied. From Turin he took a tour to Italy, where he collected some good observations concerning the natural history of the country. In the year 1744, he had the honour of being called to Versailles, to give lessons in natural philosophy to the Dauphin, at which the King and royal family were frequently present. By the excellence and amiableness of his personal character, as well as by his scientific talents, he recommended himself to the confidence of his illustrious pupil, who continued as long as he lived to express the greatest esteem for our philosopher. It is to be lamented that his liberality did not prompt him to better the mediocrity of his tutor's fortune. In the year 1749, the Abbé Nollet took a second journey into Italy, whence wonderful accounts had been circulated throughout Europe, of the communication of medicinal virtues by electricity, which seemed to be supported by numerous well-attested facts. To examine into these facts, and to be assured of their truth or fallacy, was one grand motive with our author in passing the Alps at this time, and in visiting the gentlemen who had published any accounts of those experiments. But though he engaged them to repeat their experiments in his presence, and upon himself, and though he made

it his business to get all the information which he could concerning them, he was soon convinced that the pretended facts were deceptions or exaggerations, and that no method had been discovered, by means of which the power of medicine could by electricity be made to insinuate itself into the human body. But these wonders were not the only objects which engaged our Abbé's attention in this visit to Italy; for his inquiries were extended to all the branches of natural philosophy, the arts, agriculture, &c. On his return to France, through Turin, the King of Sardinia made him an offer of the order of St. Maurice, which he thought it his duty to decline, not having the permission of his own sovereign for accepting it. In the year 1753, the King established a professorship of experimental philosophy at the Royal College of Navarre, and nominated the Abbé Nollet to fill that post. In the year 1757, the King bestowed on him the brevet of master of natural philosophy and natural history to the younger branches of the royal family of France; and in the same year appointed him professor of natural philosophy to the schools of artillery and engineers. Soon after this last preferment, he was received a pensionary of the Royal Academy of Sciences. This celebrated and laborious natural philosopher died in 1770, in the seventieth year of his age, regretted by the enlightened public, as well as the numerous friends whose attachment he had secured by the amiableness of his manners and the goodness of his heart; and more especially regretted by his poor relations, to whose relief and comfort he always paid the most affectionate attention. Besides the Royal Society of London, and the Royal Academy of Sciences at Paris, he was a member of the Institute of Bologna, the Academy of Sciences at Erfurt, and other philosophical societies and academies.

In addition to a multitude of papers inserted in the different volumes of the "Memoirs of the Academy of Sciences," from the year 1740 to the year 1767, both inclusive, the Abbé Nollet was the author of "Lessons on Experimental Philosophy," in six volumes, 12mo. "A Collection of Letters on Electricity," 1753, in three volumes, 12mo. "Enquiries into the particular Causes of Electric Phenomena," 12mo. and "The Art of making Philosophical Experiments," in three volumes, 12mo. From the articles just enumerated, as well as an anecdote already related in his life, it appears that Abbé Nollet paid particular attention to the study of electricity; and it must be acknowledged, notwithstanding the mistakes which he fell into upon the subject, that his indefatigable industry and curious experiments contributed materially to the improvement of that science. The theory of Affluences and Effluence of this philosopher, which gained considerable attention in his time, may be seen in Priestley's Electricity.

NO-*man's-land*, a space in midships, between the after-part of the belfry and the fore-part of a boat, when she is stowed upon the booms, as in a deep waisted vessel. These booms are laid upon the forecastle nearly to the quarter-deck, where their after-ends are usually sustained by a frame, called the gallows, which consists of two strong posts, about six feet high, with a cross piece reaching from one to the other athwart ships, and serving to support the ends of those booms, masts, and yards, which lie in reserve to supply the place of others carried away, &c. The above-named space is used to contain any blocks, ropes, tackles, &c. which may be necessary on the forecastle, and probably derives the name of no-man's-land from its situation, as being neither on the starboard nor larboard side of the ship, nor on the waist nor forecastle; but being situated in the middle, partakes equally of all those places.

NOMENCLATURE, a catalogue of several of the most useful words in any language, with their significations, compiled in order to facilitate the use of such words, to those who are to learn the tongue: such are our Latin, Greek, French, &c. nomenclatures.

NOMINATIVE, in grammar, the first case of nouns which are declinable. The simple position or laying down of a noun, or name, is called the nominative case; yet it is not so properly a case as the matter or ground whence the other cases are to be formed, by the several changes and inflections given to this first termination. Its chief use is to be placed in discourse before all verbs, as the subject of the proposition or affirmation.

NONAGISMAL, in astronomy, the 90th degree of the ecliptic, reckoned from the eastern term, or point. The altitude of the nonagesimal is equal to the angle of the east, and, if continued, passes through the poles of the ecliptic; whence the altitude of the nonagesimal at a given time, under a given elevation of the pole, is easily found. If the altitude of the nonagesimal be substracted from 90°, the

remainder is the distance of the nonagesimal from the vertex.

NONAGON, in mathematics, a figure having nine sides and angles. In a regular nonagon, or that the sides and angles of which are equal, if each side be 1, its area will be 6.182 nearly $= \frac{4}{9}$ of the tangent of 70° to the radius.

NON *claim*, in law, where a person has a demand upon another, and does not enforce his claim within a reasonable time, he is precluded by law from bringing his action to enforce it; and where a creditor neglects to make his claim upon a bankrupt's estate within a certain period, he will not be let in afterwards, so as to disturb the dividend, and may lose his estate. Non-claim is generally applied to the period of five years, after which a party is barred by a fine. See LIMITATION.

NON *est factum*, is a plea where an action is brought upon a bond, or any other deed, and the defendant denies it to be his deed whereon he is impleaded. In every case where the bond is void, the defendant may plead *non est factum*; but where a bond is voidable only, he must shew the special matter.

NON *pros*, if the plaintiff in an action at law neglect to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults, against the rules of law, in any subsequent stage of the action, he is adjudged not to pursue his remedy as he ought, and thereupon a non-suit, or *non prosequitur*, is entered, and he is then said to be non prosed.

NON *residence*, is applied to those spiritual persons who are not resident, but absent themselves for the space of one month together, or two months at several times in one year, from their dignities or benefices, which is liable to the penalties by the statute against non-residence, 21 Henry VIII. c. 13. But chaplains to the King, or other great persons mentioned in this statute, may be non-resident on their livings; for they are excused from residence whilst they attend those who retain them.

NON *suit*, where a person has commenced an action, and at the trial fails in his evidence to support it, or has brought a wrong action. There is this advantage attending a non-suit, that the plaintiff, though he pays costs, may afterwards bring another action for the same cause; which he cannot do, after a verdict against him.

NONCONFORMISTS, the same with dissenters. See DISSENTERS.

NONES, in the Roman calendar, the fifth day of the months January, February, April, June, August, September, November, and December; and the seventh of March, May, July, and October. March, May, July, and October, had six days in their nones; because these alone, in the ancient constitution of the year by Numa, had thirty-one days a-piece, the rest having only twenty-nine, and February thirty: but when Cæsar reformed the year, and made other months contain thirty-one days, he did not allot them six days of nones.

NORMAL, in geometry, signifies the same with a perpendicular, and is used for a line or plane that intersects another perpendicularly.

NORROY, that is *North Roy*, Northern King, in heraldry, the title of the third of the three kings at arms, or provincial heralds. His jurisdiction lies on the north side of the Trent, whence his name; as Clarencieux, on the south.

NOSE, the primary organ of smelling. See ANATOMY.

NOSTOCK, the name of a vegetable substance, which seems to differ from almost all others of the same kind. It is of a greenish colour, partly transparent, and of a very irregular figure. It trembles at the touch, like jelly, but does not melt like that. It is found in all sorts of soils, but most frequently in sandy ones, sometimes on the gravel of garden walks, usually after rain in the summer months.

NOSTRILS, in anatomy, the two apertures or cavities of the nose, through which the air passes, and which serve to convey odours, and to carry off the pituita separated in the sinuses of the base of the cranium.

NOT *guilty*, is the general issue or plea of the defendant in any criminal action or prosecution; as also in an action of trespass, or upon the case for deceits and wrongs; but not on a promise or assumpsit. It is the usual defence, where the party complains of a wrongful injury done to him.

NOTARY, is a person duly appointed to attest deeds and writings; he also protests and notes foreign and inland bills of exchange, and promissory notes, translates languages, and attests the same, enters and extends ship's protests, &c.

NOTATION, in arithmetic and algebra, the method of expressing numbers or quantities by signs or characters, appro-

priated for that purpose. See ARITHMETIC.

There is one thing which deserves particular notice, in regard to this subject, and that is, the great advantage that may redound to science by a happy notation, or expression of our thoughts. It is owing entirely to this, and the method of denoting the several combinations of numbers, by figures standing in different places, that the most complicated operations in arithmetic are managed with so much ease and dispatch. Nor is it less apparent that the discoveries made by algebra are wholly to be imputed to that symbolical language made use of in it: for by this means we are enabled to represent things in the form of equations: and by variously proceeding with these equations, to trace out, step by step, the several particulars we want to know. Add to all this, that by such a notation, the eyes and imagination are also made subservient to the discovery of truth; for the thoughts of the mind rise up and disappear, according as we set ourselves to call them into view; and, therefore, without some particular method of fixing and ascertaining them as they occur, the retrieving them when out of sight would be no less painful, than the very first exercise of deducing them one from another. As, therefore, we have frequent occasion to look back upon the discoveries already made, could these be no otherwise brought into view, than by the same course of thinking in which they were first traced, so many different attentions at once must needs greatly distract the mind, and be attended with infinite trouble and fatigue. But now, the method of fixing and ascertaining our thoughts by a happy and well chosen notation, entirely removes all those obstacles; for thus, when we have occasion to turn to any former discovery, as care is taken all along to delineate them in proper characters, we need only cast our eye on that part of the process where they stand expressed, which will lay them at once open to the mind in their true and genuine form. By this means we can take, at any time, a quick and ready survey of our progress, and running over the several conclusions already gained, see more distinctly what helps they furnish towards obtaining those others we are still in pursuit of. Nay, further, as the amount of every step of the investigation lies before us, by comparing them variously among themselves, and adjusting them one to another, we come at length to discern the result of the whole, and are enabled to form our several discoveries into an uniform and well connected system of truths, which is the end and aim of all our inquiries.

NOTES, in music, characters which mark the sounds; *i. e.* the elevations and fallings of the voice, and the swiftness and slowness of its motions. In general, under notes are comprehended all the signs or characters used in music, though in propriety the word only implies the marks which denote the degrees of gravity and acuteness to be given to each sound.

NOTONECTA, in natural history, *boat-fly*, a genus of insects of the order Hemiptera. Snout inflected; antennæ shorter than the thorax; four wings folded crosswise, coriaceous on the upper half; hind-legs hairy, formed for swimming. There are seventeen species, in two divisions, *viz.* A. Lip elongated, conic. B. Conic, spinous at the sides. N. Americana, grey, behind black; scutel deep black, with a yellow dot each side at the base; snout greenish at the base; margin and tip of the upper wings black; under wings black. It inhabits North America.

NOTOXUS, in natural history, a genus of insects of the order Coleoptera. Antennæ filiform; four feelers, hatchet-shaped; jaw one-toothed; thorax a little narrowed behind. There about thirteen species. N. monodon, thorax projecting over the head like a horn; testaceous; elytra with a black band and spots. It inhabits North America, and very much resembles N. monoceros of Europe.

NOVEL, in the civil law, a term used for the constitutions of several emperors, as of Justin, Tiberius, Leo, and more particularly of those of Justinian. The constitutions of Justinian were called novels, either from their producing a great alteration in the face of the ancient law, or because they were made on new cases, and, after the revisal of the ancient code, compiled by order of that emperor. Thus the constitutions of the emperors Theodosius, Valentinian, Marcian, &c. were also called novels, on account of their being published after the Theodosian code.

NOVEL *assignment*, or new assignment, a term in law pleadings, which it is difficult to explain to those unacquainted with practical pleading. It occurs in actions of trespass, where, the form of the declaration being very general, the defendant pleads in bar a common justification; to which the plaintiff replies, by stating that he brought his action as well for a certain other trespass, which he states

with more particularity, as for that which is justified. This is called a new assignment.

NOVEMBER, in chronology, the 11th month of the Julian year, consisting only of thirty days: it got the name of November, as being the ninth month of Romulus's year, which began with March.

NOUN, in grammar, a part of speech, which signifies things without any relation to time; as a man, a house, sweet, bitter, &c. See GRAMMAR.

NOURISHMENT. See PHYSIOLOGY.

NUDE *contract*, *nudum pactum*, a bare promise without any consideration, and not authenticated by deed, which is therefore void in law.

NUISANCE, signifies generally any thing that does hurt, inconvenience, or damage, to the property or person of another. Nuisances are of two kinds, public and private, and either affect the public or the individual. The remedy for a private nuisance is by action on the case for damages, and for a public nuisance by indictment. Amongst the nuisances which most commonly occur are the erecting of noxious manufactures in towns, and in the vicinity of ancient houses; such as the erecting a vitriol manufactory, to the annoyance of the neighbours in general. Disorderly houses, bawdy houses, stage booths, lotteries, and common scolds, are also public nuisances. Where the injury is merely to an individual, and not to the public, the individual only has an action, but not in the case of a public nuisance, where the private injury is merged, or lost, in that of the public, but where an individual receives a particular injury by a public nuisance. And any one aggrieved may abate, that is, pull down and remove a nuisance, after which he can have no action: but this is a dangerous attempt to take the law into one's own hands. It must be done without riot, if at all. Every continuance of a nuisance is a fresh nuisance, and a fresh action will lie.

NUL *tiel record*, no such record in law, is the replication which the plaintiff makes to the defendant, when the latter pleads a matter of record in bar to the action, and it is necessary to deny the existence of such record, and to join issue on that fact.

NUMBER, a collection of several units, or of several things of the same kind, as 2, 3, 4, &c. Number is unlimited in respect of increase, because we can never conceive a number so great, but still there is a greater. However, in respect of decrease it is limited; unity being the first and least number, below which therefore it cannot descend.

NUMBERS, *kinds and distinctions of.* Mathematicians, considering number under a great many relations, have established the following distinctions. Broken numbers, are the same with fractions. See ARITHMETIC. Cardinal numbers are those which express the quantity of units, as 1, 2, 3, 4, &c.; whereas ordinal numbers, are those which express order, as 1st, 2d, 3d, &c. Compound number, one divisible by some other number besides unity; as 12, which is divisible by 2, 3, 4 and 6. Numbers, as 12 and 15, which have some common measure besides unity, are said to be compound numbers among themselves. Cubic number, is the product of a square number by its root: such is 27, as being the product of the square number 9, by its root 3. All cubic numbers whose root is less than 6, being divided by 6, the remainder is the root itself: thus 27÷6 leaves the remainder 3, its root; 216, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which, added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which added to 6, is the cube root. Hence the remainders of the divisions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube so divided, till that remainder be 5, and consequently 11, the cube root of the number divided. But the cubic numbers above this being divided by 6, there remains nothing, the cube root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6; till you come to 18, when the remainder of the division must be added to 18; and so on *ad infinitum.* From considering this property of the number 6, with regard to cubic numbers, it has been found that all other numbers, raised to any power whatever, had each their divisor, which had the same effect with regard to them that 6 has with regard to cubes. The general rule is this: "If the exponent of the power of a number be even, that is, if that number be raised to the 2d, 4th, 6th, &c. power, it must be divided by 2; then the remainder added to 2, or to a multiple of 2, gives the root of the number corresponding to its power, that is the 2d, 4th, and root. But if the exponent of the power of the number be uneven,

the 3d, 5th, 7th power, the double of that exponent is the divisor that has the property required.

Determinate number, is that referred to some given unit, as a ternary or three: whereas an indeterminate one, is that referred to unity in general, and is called quantity. Homogeneal numbers, are those referred to the same unit; as those referred to different units are termed heterogeneal. Whole numbers are otherwise called integers. Rational number, is one commensurable with unity; as a number, incommensurable with unity, is termed irrational, or a surd. See SURD. In the same manner a rational whole number is that whereof unity is an aliquot part; a rational broken number, that equal to some aliquot part of unity; and a rational mixed number, that consisting of a whole number and a broken one. Even number, that which may be divided into two equal parts without any fraction, as 6, 12, &c. The sum, difference, and product of any number of even numbers, is always an even number. An evenly even number, is that which may be measured, or divided, without any remainder, by another even number, as 4 by 2. An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5. Uneven number, that which exceeds an even number, at least by unity, or which cannot be divided into two equal parts, as 3, 5, &c. The sum or difference of two uneven numbers make an even number; but the factum of two uneven ones make an uneven number. If an even number be added to an uneven one, or if the one be subtracted from the other, in the former case the sum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even. The sum of any even number of uneven numbers is an even number; and the sum of any uneven number of uneven numbers is an uneven number. Primitive, or prime numbers, are those only divisible by unity, as 5, 7, &c. And prime numbers among themselves, are those which have no common measure besides unity, as 12 and 19. Perfect number, that whose aliquot parts added together make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1, = 6; and those of 28 being 14, 7, 4, 2, 1, = 28. Imperfect numbers, those whose aliquot parts, added together, make either more or less than the whole. And these are distinguished into abundant and defective; an instance in the former case is 12, whose aliquot parts 6, 4, 3, 2, 1, make 16; and in the latter case 16, whose aliquot parts 8, 4, 2, and 1, make but 15. Plain number, that arising from the multiplication of two numbers, as 6, which is the product of 3 by 2; and these numbers are called the sides of the plane. Square number, is the product of any number multiplied by itself: thus 4, which is the factum of 2 by 2, is a square number. Every square number added to its root makes an even number. Polygonal, or polygonous numbers, the sums of arithmetical progressions beginning with unity: these, where the common difference is 1, are called triangular numbers; where 2, square numbers; where 3, pentagonal numbers; where 4, hexagonal numbers; where 5, heptagonal numbers, &c. See POLYGONAL. Pyramidal numbers: the sums of polygonous numbers, collected after the same manner as the polygons themselves, and not gathered out of arithmetical progressions, are called first pyramidal numbers: the sums of the first pyramidals are called second pyramidals, &c. If they arise out of triangular numbers, they are called triangular pyramidal numbers; if out of pentagons, first pentagonal pyramidals. From the manner of summing up polygonal numbers, it is easy to conceive how the prime pyramidal numbers are found, *viz.* $\frac{(a-2)n^3 + 3n^2 - (a-5)n}{6}$ expresses all the prime pyramidals.

NUMBER *of direction*, in chronology, some one of the 35 numbers between the Easter limits, or between the earliest and latest day on which it can fall; *i. e.* between the 22d of March and the 25th of April. Thus, if Easter Sunday fall as in the first line below, the number of direction will be as on the lower line.

	March.										April.			
Easter-day	22,	23,	24,	25,	26,	27,	28,	29,	30,	31.	1,	2,	3,	&c.
Number of direction	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12,	13,	&c.

and so on, till the number of direction and the sum will be so many days in March for the Easter-day; if the sum exceed 31, the excess will be the day of April. To find the number of direction: enter the following table with the dominical letter on the left hand, and the golden number at top; then where the columns meet is the number of direction for that year.

G. N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Dom. Let.																			
A	29	19	5	26	12	33	19	12	26	19	5	26	12	5	26	12	33	19	12
B	27	13	6	27	13	34	20	13	27	20	6	27	13	6	20	13	34	20	6
C	8	4	7	21	14	35	21	7	28	21	7	28	14	7	21	14	28	21	7
D	19	15	8	22	15	29	22	8	29	15	8	29	15	1	22	15	29	22	8
E	30	16	2	23	16	30	23	9	30	16	9	23	16	2	23	9	30	23	9
F	24	17	3	24	10	31	24	10	31	17	10	24	17	3	24	10	31	17	10
G	25	18	4	25	11	32	18	11	32	18	4	25	18	4	25	11	32	18	11

Thus, for the year 1808, the dominical letter being B, and the golden number 4, we find the number of direction 27, to which add 21, and the sum is 48 from the 1st of March, deduct 31 for the number of days in March, and the remainder gives the day of April for Easter Sunday.

NUMBER, *golden*, in chronology. See GOLDEN *number*.

NUMBER, in grammar, a modification of nouns, verbs, &c. to accommodate them to the varieties in their objects, considered with regard to number. See GRAMMAR.

NUMBERS, in poetry, oratory, music, &c. are certain measures, proportions, or cadences, which render a verse, period, or song, agreeable to the ear.

NUMERAL *letters*, those letters of the alphabet which are generally used for figures, as I, V, X, L, C, D, M.

NUMERATION, or *notation*, the art of expressing in characters any number proposed in words; or of expressing in words any number proposed in characters. See ARITHMETIC; NOTATION.

NUMERICAL, or NUMERAL, something belonging to numbers; as numerical algebra is that which makes use of numbers instead of letters of the alphabet. Also, numerical difference is the difference whereby one individual is distinguished from another. Hence a thing is said to be numerically the same, when it is so in the strictest sense of the word.

NUMIDIA, the PINTADO, or *guinea-hen*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill strong and short, with a carunculate cere at the base, in which the nostrils are lodged; head horned, with a compressed coloured callus; wattles hanging from the cheeks; tail short, and pointing downwards; body speckled. There are four species. N. meleagris, is of the size of a very large fowl, and is the meleagris of the ancients, who used to prize it as a high delicacy. Its native territory is Africa, and particularly, perhaps, Nubia. It is gregarious, having been often seen in very numerous flocks. It is now extremely common in this country. The female lays many eggs, and, secreting her nest, sometimes will suddenly appear with a family of twenty young ones. It is a bird of harsh sound, and almost perpetually uttering it. The flesh of the young birds is valued, and its eggs are thought preferable to those of the common hen. See Aves, Plate X. fig. 5.

NUNEZ (PERO), in biography, one of the ablest mathematicians of his time, born at Alcaza do Sal, in Portugal. He taught publicly in the university of Coimbra, and instructed the Infante de Luis so well, that it is said he fitted him for a professor. Pero Nunez is well known, in the history of science, as the person who made the first improvement in the method of reading an observed angle, and the scale which he invented for this purpose, though it has received some improvements, is still called the Nonius, his latinized name. His works are numerous.

NUT-*galls* are excrescences formed on leaves of the oak by the puncture of an insect, which deposits an egg in them. The best are known by the name of Aleppo-galls, imported very largely into this country for the use of dyers, calico-printers, &c. These are hard like wood, of a blueish colour, and of a disagreeable taste. They are partly soluble in water, and what remains is tasteless and possesses the properties of the fibre of wood. By experiments Mr. Davy found that 500 grains of Aleppo-galls formed with water a solu-

tion, which yielded by slow evaporation 185 grains of matter, which was composed of

Tannin	130
Gallic acid and extract	31
Mucilage and extract	12
Lime and saline matter	12
	185

See TANNIN.

NUTATION, in astronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution it is twice inclined to the ecliptic, and as often returns to its former position.

Sir Isaac Newton observes, that the moon has the like motion, only very small, and scarcely sensible.

NUTMEG, in natural history, the kernel of a large fruit, not unlike the peach, the produce of a tree called, by botanists, MYRISTICA, which see.

The nutmeg is separated from its investient coat, the mace, before it is sent over to us; except that the whole fruit is sometimes imported in preserve, by way of sweetmeat, or as a curiosity. See MACE.

The nutmeg, as we receive it, is of a roundish or oval figure, of a tolerably compact and firm texture, but easily cut with a knife, and falling to pieces on a smart blow. Its surface is not smooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyish brown colour on the outside, and of a beautiful variegated hue within, being marbled with brown and yellow variegations, running in perfect irregularity through its whole substance. It is very unctuous and fatty to the touch, when powdered, and is of an extremely agreeable smell, and of an aromatic taste, without the heat that attends that kind of flavour in most of the other species.

There are two kinds of nutmeg in the shops, the one called by authors the male, and the other the female. The female is the kind in common use, and is of the shape of an olive: the male is long and cylindric, and has less of the fine aromatic flavour than the other, so that it is much less esteemed, and people who trade largely in nutmegs will seldom buy it. Besides this oblong kind of nutmegs, we sometimes meet with others of perfectly irregular figures, but mere lusus naturæ, not owing to a different species of the tree. The longer male nutmeg, as we term it, is called by the Dutch the wild nutmeg. It is always distinguishable from the others, as well by its want of fragrancy, as by its shape: it is very subject to be worm-eaten, and is strictly forbid, by the Dutch, to be packed up among the other, because it will give occasion to their being worm-eaten by the insects getting from it into them, and breeding in all parts of the parcel. The largest, heaviest, and most unctuous of the nutmegs are to be chosen, such as are the shape of an olive, and of the most fragrant smell.

NUTRITION. See PHYSIOLOGY.

NYCTANTHES, in botany, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla, salver shaped, with truncated segments; capsule, two-celled, margined; seeds solitary. There are seven species, of which N. undulata, wave-leaved Nyctanthes, is a shrub about six feet in height, the young shoots are hairy; leaves of a shining green, smooth, in pairs from the joints, bitter, without any smell; flowers white; calycine segments six; of the corolla six, seven or eight, narrow, much waved on the edge; fruit superior, resembling a black cherry, containing a round hairy seed. It is a native of the East Indies, where it is much cultivated on account of the sweetness of the flowers, which are worn by the ladies in their hair.

NYMPH, or PUPA, among naturalists, that state of winged-insects between their living in the form of a worm, and their appearing in the winged or most perfect state.

The eggs of insects are first hatched into a kind of worms, or maggots; which afterwards pass into the nymph-state, surrounded with shells or cases of their own skins; so that, in reality, these nymphs are only the embryo-insects, wrapped up in this covering; from whence they at last get loose, though not without great difficulty.

Linnæus applied the term Pupa to this state of the insect, from a fancied resemblance which it bears to a child wrapped in swaddling clothes, according to the old European fashion.

NYMPHÆ. See ANATOMY.

NYMPHÆA, in botany, *water-lily*, a genus of the Polyandria Monogynia class and order. Natural order of Succulentæ. Hydrocharides, Jussieu. Essential character, calyx four, five, or six leaved; co-

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rolla many petalled; berry many celled, truncated. There are six species, of which N. alba, white water-lily, has a tuberous root, creeping far and wide in the mud; the whole plant is larger than the yellow water-lily; petioles and peduncles round, within full of pores; flowers large and very handsome, petals white, from sixteen to twenty in number; stamens sixty-eight, or seventy; germ roundish; style none; stigma rayed; according to Linnæus, the flower raises itself out of the water and expands about seven o'clock in the morning, closing again, and reposing upon the surface of the water soon after four in the evening.

The roots have an astringent bitter taste; they are used in Ireland, and in the Highlands of Scotland, to dye a dark brown or chesnut colour; this plant is a native of most parts of Europe, in slow streams, pools and ditches, flowering in July and August.

NYSSA, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Holoraceæ. Elæagmi, Jussieu. Essential character: calyx, five parted; corolla none: male, stamens ten: hermaphrodite, stamens five; pistil one; drupe inferior. There are two species, *viz.* N. integrifolia, mountain tupelo; and N. denticulata, water tupelo; the former of which grows naturally in Pennsylvania, rising to the height of thirty or forty feet, and nearly two in diameter, sending off many horizontal and often depending branches; leaves of a dark green colour on the upper surface, but lighter underneath; the flowers are produced upon long footstalks, from the base of the young shoots, dividing irregularly into several parts, each supporting a small flower; the female trees have fewer flowers, produced upon much longer simple cylindrical footstalks. The Virginian water tupelo tree grows naturally in wet swamps, or near large rivers in Carolina and Florida, rising with a strong upright trunk to the height of eighty or an hundred feet, dividing into many branches towards the top; the leaves are large, of an oval spear-shaped form; the berries are nearly the size and shape of small olives, and are preserved by the French inhabitants upon the Mississippi, where it abounds, and is called the olive tree.

O.

O, or o, the fourteenth letter, and fourth vowel of our alphabet, pronounced as in the words *nose, rose,* &c.

The sound of this letter is often so soft as to require it double, and that chiefly in the middle of words; as *goose, reproof,* &c. and in some words this *oo* is pronounced like *u* short, as in *flood, blood,* &c.

As a numeral, O is sometimes used for eleven; and with a dash over it, thus, $\overline{O}$, for eleven thousand.

In music, the O, or rather a circle, or double CↃ, is a note of time, called by us a semi-breve; and, by the Italians, circolo. The O is also used as a mark of triple time, as being the most perfect of all figures. See TRIPLE.

OAK. See QUERCUS.

OAKUM, old ropes untwisted, and pulled out into loose hemp, in order to be used in caulking the seams, tree nails, and bends of a ship, for stopping or preventing leaks.

OAR, in navigation, a long piece of wood, made round where it is to be held in the hand, and thin and broad at the other end, for the easier cutting and resisting the water, and consequently moving the vessel, by rowing.

OAT. See AVENA.

OBELISK, in architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

OBJECT, in philosophy, something apprehended, or presented to the mind, by sensation or by imagination.

OBJECT *glass of a telescope, or microscope,* the glass placed at the end of the tube which is next the object.

To prove the goodness and regularity of an object-glass, on a paper, describe two concentric circles, the one having its diameter the same with the breadth of the object-glass, and the other half that diameter; divide the smaller circumfer-

ence into six equal parts, pricking the points of division through with a fine needle; cover one side of the glass with this paper, and, exposing it to the sun, receive the rays through these six holes upon a plane; then by moving the plane nearer to, or further from the glass, it will be found whether the six rays unite exactly together at any distance from the glass; if they do, it is a proof of the regularity and just form of the glass; and the said distance is also the focal distance of the glass. A good way of proving the excellency of an object-glass, is by placing it in a tube, and trying it with small eye-glasses, at several distant objects; for that object-glass is always the best which represents objects the brightest and most distinct, and which bears the greatest aperture, and the most convex and concave eye-glasses, without colouring or haziness. A circular object-glass is said to be truly centered when the centre of its circumference falls exactly in the axis of the glass; and to be ill centered when it falls out of the axis. To prove whether object-glasses be well centered, hold the glass at a due distance from the eye, and observe the two reflected images of a candle, varying the distance till the two images unite, which is the true centre point: then if this fall in the middle, or central point of the glass, it is known to be truly centered. As object-glasses are commonly included in cells that screw upon the end of the tube of a telescope, it may be proved whether they be well centered by fixing the tube, and observing, while the cell is unscrewed, whether the cross-hairs keep fixed upon the same lines of an object seen through the telescope.

OBJECTIVE *line*, in perspective, is any line drawn on the geometrical plane, whose representation is sought for in a draught or picture: and the *objective plane* is any plane situated in the horizontal plane, the representation of which is required. See PERSPECTIVE.

OBLATE, flattened, or shortened, as an oblate spheroid, having its axis shorter than its middle diameter, being formed by the rotation of an ellipse about the shorter axis. The oblateness of the earth refers to the diminution of the polar axis in respect of the equatorial. The ratio of these two axes has been determined in various ways; sometimes by the measures of different degrees of latitude, and sometimes by the length of pendulums, vibrating seconds in different latitudes. See EARTH, DEGREE, &c.

OBLIGATION, in law, a bond containing a penalty, with a condition annexed, either for payment of money, performance of covenants, or the like. This security is called a specialty. See BOND and DEED.

OBLIGOR, in law, he who enters into an obligation; as obligee is the person to whom it is entered into.

OBLIQUE, in geometry, something aslant, or that deviates from the perpendicular. Thus an oblique angle is either an acute or obtuse one, *i. e.* any angle except a right one. See ANGLE.

OBLIQUE *cases*, in grammar, are all the cases except the nominative.

OBLIQUE *line*, that which, falling on another line, makes oblique angles with it, *viz.* one acute, and the other obtuse.

OBLIQUE *planes*, in dialling, are those which recline from the zenith, or incline towards the horizon.

The obliquity, or quantity of this inclination, or reclination, may be found by means of a quadrant.

OBLIQUE *sailing*, in navigation, is when a ship sails upon some rhumb between the four cardinal points, making an oblique angle with the meridian; in which case she continually changes both latitude and longitude. Oblique sailing is of three kinds, *viz.* plain sailing, Mercator's sailing, and great circle sailing. See NAVIGATION.

OBLIQUE *sphere*, is where the pole is elevated any number of degrees less than 90°: in which case the axis of the world, the equator, and parallels of declination, will cut the horizon obliquely.

OBLIQUITY *of the ecliptic*. See ECLIPTIC.

OBLIQUUS, in anatomy, *oblique*, a name given to several muscles, particularly in the head, eyes, and abdomen. See ANATOMY.

OBOLARIA, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx two-leaved; corolla four-cleft, bell-shaped; stamina, from the slits of the corolla; capsule one-celled, two-valved, many-seeded. There is but one species, *viz.* O. Virginica.

OBSERVATION, in astronomy and navigation, is the observing with an instrument some celestial phenomenon, as the altitude of the sun, moon, and stars, or their distances from each other. But by this term, mariners commonly mean only the taking the meridian altitudes, in order to find the latitude; and the finding

the latitude from such observed latitude, they call "working an observation."

OBSERVATORY, a place destined for observing the heavenly bodies; it is a building usually in form of a tower, erected on an eminence, and covered with a terrace for making astronomical observations. Most nations have had observatories, which have been noticed at large in La Lande's Astronomy: of these, the following may be mentioned:

The Greenwich Observatory, or Royal Observatory of England. This was built and endowed in the year 1676, by order of King Charles the Second, at the instance of Sir Jonas Moore, and Sir Christopher Wren; the former of these gentlemen being Surveyor General of the Ordnance, the office of Astronomer Royal was placed under that department, in which it has continued ever since.

This observatory was at first furnished with several very accurate instruments; particularly a noble sextant of seven feet radius, with telescopic sights. And the first Astronomer Royal, or the person to whom the province of observing was first committed, was Mr. John Flamsteed; a man who, as Dr. Halley expresses it, seemed born for the employment. During fourteen years he watched the motions of the planets with unwearied diligence, especially those of the moon, as was given him in charge; that a new theory of that planet being found, shewing all her irregularities, the longitude might thence be determined. In the year 1690, having provided himself with a mural arch of near seven feet radius, made by his assistant, Mr. Abraham Sharp, and fixed in the plane of the meridian, he began to verify his catalogue of the fixed stars, which had hitherto depended altogether on the distances measured with the sextant, after a new and very different manner, *viz.* by taking the meridian altitudes, and the moments of culmination, or in other words, the right ascension and declination. And he was so well pleased with this instrument, that he discontinued almost entirely the use of the sextant. Thus, in the space of upwards of forty years, the Astronomer Royal collected an immense number of good observations; which may be found in his "Historia Cœlestis Britannica," published in 1725; the principal part of which is the Britannic Catalogue of the fixed stars.

Mr. Flamsteed, on his death in 1719, was succeeded by Dr. Halley, and he by Dr. Bradley in 1742, and this last by Mr. Bliss in 1762; but none of the observations of these gentlemen have yet been given to the public.

On the demise of Mr. Bliss, in 1765, he was succeeded by Dr. Nevil Maskelyne, the present Astronomer Royal, whose valuable observations have been published, from time to time, under the direction of the Royal Society, in several folio volumes.

The Greenwich Observatory is found, by very accurate observations, to lie in 51° 28′ 40″ north latitude, as settled by Dr. Maskelyne, from many of his own observations, as well as those of Dr. Bradley.

The Paris Observatory was built by Louis the Fourteenth, in the Fauxbourg St. Jaques; being begun in 1664, and finished in 1672. It is a singular but magnificent building, of eighty feet in height, with a terrace at top; and here M. de la Hire, M. Cassini, &c. the King's Astronomers, have made their observations. Its latitude is 48° 50′ 14″ north, and its longitude 9′ 20″ east of Greenwich Observatory.

In the Observatory of Paris is a cave, or pit, 170 feet deep, with subterraneous passages, for experiments that are to be made out of the reach of the sun, especially such as relate to congelations, refrigerations, &c. In this cave there is an old thermometer of M. de la Hire, which stands at all times at the same height; thereby shewing that the temperature of the place remains always the same. From the top of the platform to the bottom of the cave is a perpendicular well or pit, used formerly for experiments on the fall of bodies; being also a kind of long telescopical tube, through which the stars are seen at mid-day.

Tycho Brahe's Observatory was in the little island Ween, or the Scarlet Island, between the coasts of Schonen and Zealand, in the Baltic Sea. This observatory was not well situated for some kinds of observations, particularly the risings and settings; as it lay too low, and was land-locked on all the points of the compass except three; and the land horizon being very rugged and uneven.

Pekin Observatory. Father Le Compte describes a very magnificent observatory, erected and furnished by the late Emperor of China, in his capital, at the intercession of some Jesuit missionaries, chiefly Father Verbest, whom he appointed his chief observer. The instruments here are exceedingly large; but the divisions are less accurate; and, in some respects, the contrivance is less commodious than

in those of the Europeans. The chief are, an armillary zodiacal sphere of six Paris feet diameter, an azimuthal horizon six feet diameter, a large quadrant six feet radius, a sextant eight feet radius, and a celestial globe six diameter.

Bramin's Observatory at Benares, in the East Indies, which is still one of the principal seminaries of the Bramins, or priests of the original Gentoos of Hindostan. This observatory at Benares, it is said, was built about 200 years since, by order of the Emperor Ackbar; for as this wise prince endeavoured to improve the arts, so he wished also to recover the sciences of Hindostan, and therefore ordered that three such places should be erected; one at Delhi, another at Agra, and the third at Benares.

Wanting the use of optical glasses, to magnify very distant, or very small objects, these people directed their attention to the increasing the size of their instruments, for obtaining the greater accuracy and number of the divisions and subdivisions in their instruments. Accordingly, the observatory contains several huge instruments of stone, very nicely erected and divided, consisting of circles, columns, gnomons, dials, quadrants, &c. some of them of 20 feet radius, the circle divided first into 360 equal parts, and sometimes each of these into 20 other equal parts, each answering to 3′, and of about two tenths of an inch in extent. And although these wonderful instruments have been built upwards of 200 years, the graduations and divisions on the several arcs appear as well cut, and as accurately divided, as if they had been the performance of a modern artist. The execution, in the construction of these instruments, exhibits an extraordinary mathematical exactness in the fixing, bearing, fitting of the several parts, in the necessary and sufficient supports to the very large stones that compose them, and in the joining and fastening them into each other by means of lead and iron.

We have referred to this article from the Equatorial, for some account of practical astronomy, and the instruments used in this branch of science.

By practical astronomy is implied the knowledge of observing the celestial bodies, with respect to their position and time of the year, and of deducing from those observations certain conclusions, useful in calculating the time when any proposed position of these bodies shall happen. For this purpose, it is necessary to have a room or place conveniently situated, suitably contrived, and furnished with proper astronomical instruments. It should have an uninterrupted view from the zenith down to, or even below, the horizon, at least towards the cardinal points; and for this purpose, that part of the roof which lies in the direction of the meridian, in particular, should have moveable covers, which may easily be moved, by which means an instrument may be directed to any point of the heavens between the horizon and the zenith, as well to the northward as southward. This place, called an observatory, should contain the following instruments:

I. *A Pendulum Clock*, for showing equal time. This should show time in hours, minutes, and seconds: the observer, by hearing the beats of the pendulum, may count them by his ear, while his eye is employed on the motion of the celestial object he is observing. Just before the object arrives at the position described, the observer should look on the clock and remark the time, suppose it 9 hours, 15 minutes, 25 seconds; then saying, 25, 26, 27, 28, &c. responsive to the beat of the pendulum, till he sees through the instrument the object arrived at the position expected; which suppose to happen when he says thirty-eight, he then writes down 9h 15′ 38″ for the time of observation, annexing the particular day. If two persons are concerned in making the observation, one may read the time audibly while the other observes through the instrument, the observer repeating the last second read when the desired position happens.

II. *An Achromatic Refracting Telescope*, or a reflecting one of two feet at least in length, for observing particular phenomena. See Telescope.

III. *A Micrometer* for measuring small angular distances. See Micrometer.

IV. *A Quadrant*, for a description of which, and its several uses, we refer to the article Quadrant. We may, however, observe, that besides Hadley's quadrant, which is described there, we have the mural quadrant, which is reckoned one of the most useful and valuable of all the astronomical instruments, and is generally fixed to the side of a stone or brick wall, and the plane of it is erected exactly in the plane of the meridian. There is also a portable astronomical quadrant, which is in high estimation, on account of its being capable of being carried to any part of the world, and put

up for the purposes of observation by almost any common workman.

V. *Astronomical or Equatorial Sector.* This is an instrument for finding the difference in right ascension and declination between two objects, the distance of which is too great to be observed by the micrometer. Let A B (Plate Observatory, fig. 1.) represent an arch of a circle containing ten or twelve degrees well divided, having a strong plate, CD, for its radius, fixed to the middle of the arch at D. Let this radius be applied to the side of an axis, H F I, and be moveable about a joint fixed to it at F, so that the plane of the sector may be always parallel to the axis H I, which being parallel to the axis of the earth, the plane of the sector will always be parallel to the plane of some hour circle. Let a telescope, C E, be moveable about the centre, C, of the arch, A B, from one end of it to the other, by turning a screw at G, and let the line of sight be parallel to the plane of the sector. Now, by turning the whole instrument about the axis, H I, till the plane of it be successively directed, first to one of the stars, and then to another, it is easy to move the sector about the joint F, into such a position, that the arch, A B, when fixed, shall take in both the stars in their passage, by the plane of it, provided the difference of their declinations does not exceed the arch, A B. Then, having fixed the plane of the sector a little to the westward of both the stars, move the telescope, C E, by the screw, G, and observe by a clock the time of each transit over the cross hairs, and also the degrees and minutes upon the arch, A B, cut by the index at each transit; then in the difference of the arches, the difference of the declinations, and by the difference of the times, we have the difference of the right ascensions of the stars. The dimensions of this instrument are these; the length of the telescope, or the radius of the sector, is two feet and a half: the breadth of the radius, near the end C, is an inch and a half, and at the end, D, two inches: the breadth of the limb, A B, is one inch and a half, and its length six inches, containing ten degrees, divided into quarters, and numbered from either end to the other.

The telescope carries a nonius, or subdividing plate, whose length being equal to sixteen quarters of a degree, is divided into fifteen equal parts, which, in effect, divides the limb into minutes, and, by estimation, into smaller parts. The length of the square axis, H I F, is eighteen inches, and of the part, H I, twelve inches; and its thickness is about a quarter of an inch. The diameters of the circles are each five inches; the thickness of the plates, and the other measures, may be taken at the direction of a workman. This instrument may be rectified for making observations in this manner: By placing the intersection of the cross hairs at the same distance from the plane of the sector as the centre of the object-glass, the plane described by the line of sight, during the circular motion of the telescope upon the limb, will be sufficiently true, or free from conical curvity, which may be examined by suspending a long plumb-line at a convenient distance from the instrument, and by fixing the plane of the sector in a vertical position; and then by observing, while the telescope is moved by the screw along the limb, whether the cross-hairs appear to move along the plumb-line. The axis, *h f o*, may be elevated nearly parallel to the axis of the earth, by means of a small common quadrant, and its error may be corrected by making the line of sight follow the circular motion of any of the circumpolar stars, while the whole instrument is moved about its axis, *h f o*, the telescope being fixed to the limb; for this purpose, let the telescope, *k l a*, be directed to the star *a*, when it passes over the highest point of its diurnal circle, and let the division cut by the nonius be noted; then, after twelve hours, when the star comes to the lowest point of its circle, having turned the instrument half round its axis, to bring the telescope into the position *m n*, if the cross hairs cover the same star supposed at *b*, the elevation of the axis, *h f o*, is exactly right; but if it be necessary to move the telescope into the position, *u f c*, in order to point to this star at *c*, the arch *m u*, which measures the angle *m f u*, or *b f c*, will be known; and then the axis, *h f o*, must be depressed half the quantity of this given angle if the star passed below *b*, or must be raised so much higher if above it; and then the trial must be repeated till the true elevation of the axis be obtained.

By making the like observations upon the same star on each side the pole in the six o'clock hour circle, the error of the axis, toward the east or west, may also be found and corrected, till the cross hairs follow the star quite round the

pole; for supposing $a\ o\ p\ b\ c$, to be an arch of the meridian, make the angle $a\ f\ p$, equal to half the angle $a\ f\ c$, and the line $f\ p$, will point to the pole; and if the angle $o\ f\ p$, which is the error of the axis, will be equal to half the angle, $b\ f\ c$, or $m\ f\ u$, found by the observation; because the difference of the two angles, $a\ f\ h$, $a\ f\ c$, is double the difference of their halves, $a\ f\ o$, and $a\ f\ p$. Unless the star be very near the pole, allowance must be made for refractions. See QUADRANT.

VI. *Transit and Equal Altitude Instruments.* The transit instrument is used for observing objects as they pass over the meridian. It consists of a telescope fixed at right angles to a horizontal axis; which axis must be so supported, that what is called the line of collimation, or line of sight of the telescope, may move in the plane of the meridian. This instrument is made of various sizes, and of large dimensions, in our great observatories; but the following is one of a size sufficiently large and accurate for all the useful purposes. The axis, A B (fig. 2), to which the middle of the telescope is fixed, is about two feet and a half long, tapering gradually toward its ends, which terminate in cylinders well turned and smoothed. The telescope, C D, which is about four feet, and an inch and a half diameter, is connected with the axis by means of a strong cube or die, G, and in which the two cones, M Q, forming the axis, are fixed. This cube G, serves as the principal part of the whole machine. It not only keeps together the two cones, but holds the two sockets, K H, of fifteen inches length, for the two telescopic tubes. Each of these sockets has a square base, and is fixed to the cube by four screws. These sockets are cut down in the sides about eight inches, to admit more easily the tube of the telescope; but when the tube is inserted, it is kept in firm by screwing up the tightening screws at the end of the sockets at K and H. These two sockets are very useful in keeping the telescope in its greatest possible degree of steadiness. They also afford a better opportunity of balancing the telescope, and rectifying its vertical thread, than by any other means. In order to direct the telescope to the given height that a star would be observed at, there is fixed a semicircle, A N, on one of the supporters, of about eight inches and a half diameter, and divided into degrees. The index is fixed on the axis, at the end of which is a vernier, which subdivides the degrees into twelve parts of five minutes. The index is moveable on the axis, and may be closely applied to the divisions by means of a tightening screw. Two upright posts of wood or stone, Y Y, firmly fixed at a proper distance, are to sustain the supporters of this instrument. These supporters are two thick brass plates, R R, having well smoothed angular notches in their upper ends, to receive the cylindrical arms of the axis. Each of these notched plates is contrived to be moveable by a screw, which slides them upon the surfaces of two other plates immoveably fixed upon the two upright pillars; one plate moving in a horizontal, and the other in a vertical direction; or, which is more simple, these two modes are sometimes applied only on one side, as at V and P, the horizontal motion by the screw P, and the vertical by the screw V. These two motions serve to adjust the telescope to the plane of the horizon and meridian: to the plane of the horizon by the spirit-level, E F (fig. 4) hung by D C on the axis M Q, in a parallel direction, and to the plane of the meridian in the following manner: Observe by the clock when a circumpolar star seen through this instrument transits both above and below the pole: and if the times of describing the eastern and western parts of its circuit are equal, the telescope is then in the plane of the meridian: otherwise the screw, P, must be gently turned, that it may move the telescope so much that the time of the star's revolution be bisected by both the upper and lower transits, taking care at the same time that the axis remains perfectly horizontal. When the telescope is thus adjusted, a mark must be set at a considerable distance (the greater the better) in the horizontal direction of the intersection of the cross wires, and in a place where it can be illuminated in the night-time by a lanthorn hanging near it; which mark being on a fixed object, will serve at all times afterwards to examine the position of the telescope by the axis of the instrument being first adjusted by means of the level.

To adjust the Clock by the Sun's Transit over the Meridian. Note the times by the clock when the preceding and following edges of the Sun's limb touch the cross wires. The difference between the middle time and twelve hours, shows how much the mean time, or time by the clock, is faster or slower than the apparent or solar time for that day; to which

the equation of time being applied, will show the time of mean noon for that day, by which the clock may be adjusted.

The Equal Altitude Instrument, is an instrument that is used to observe a celestial object when it has the same altitude on both the east and west sides of the meridian, or in the morning and afternoon. It principally consists of a telescope about thirty inches long, fixed to a sextantal or semicircular divided arch, the centre of which is fixed to a long vertical axis.

The Equatorial or Portable Observatory, an instrument designed to answer a number of useful purposes in practical astronomy, independent of any particular observatory. It may be made use of in any steady room or place, and performs most of the useful problems in the science. The following is a description of one lately invented by Mr. Ramsden, from whom it has received the name of the Universal Equatorial. The principal parts of this instrument (fig. 3.) are, 1. The azimuth or horizontal circle, A, which represents the horizon of the place, and moves on an axis, B, called the vertical axis. 2. The equatorial or hour circle, C, representing the equator, placed at right angles to the polar axis, D, or the axis of the earth, upon which it moves. 3. The semicircle of declination, E, on which the telescope is placed, and moving on the axis of declination, or the axis of motion of the line of collimation, F. 4. The telescope, which is an achromatic refractor with a triple object glass, whose focal distance is 17 inches, and aperture 2.45 inches, and furnished with six different eye-tubes; so that its magnifying powers extend from 44 to 168. The telescope in this equatorial may be brought parallel to the polar axis, as in the figure, so as to point to the pole star in any part of its diurnal revolution; and thus it has been observed near noon, when the sun has shone very bright. 5. The apparatus for correcting the error in altitude occasioned by refraction, which is applied to the eye-end of the telescope, and consists of a slide, G, moving in a groove or dove-tail, and carrying the several eye-tubes of the telescope, on which slide there is an index corresponding to five small divisions engraved on the dove-tail; a very small circle, called the refraction circle, H, moveable by a finger screw at the extremity of the eye-end of the telescope; which circle is divided into half minutes, one entire revolution of it being equal to 3′ 18″, and by its motion raises the centre of the cross hairs on a circle of altitude; and likewise a quadrant, I, of 1½ inch radius, with divisions on each side, one expressing the degree of altitude of the object viewed, and the other expressing the minutes and seconds of error occasioned by refraction, corresponding to that degree of altitude; to this quadrant is joined a small round level, K, which is adjusted partly by the pinion that turns the whole of this apparatus, and partly by the index of the quadrant; for which purpose the refraction circle is set to the same minute, &c. which the index points to on the limb of the quadrant; and if the minute, &c. given by the quadrant exceed the 3′ 18″ contained in one entire revolution of the refraction circle, this must be set to the excess above one or more of its entire revolutions; then the centre of the cross hairs will appear to be raised on a circle of altitude to the additional height which the error of refraction will occasion at that altitude. This instrument stands on three feet, L, distant from each other 14.4 inches; and when all the parts are horizontal, is about 29 inches high: the weight of the equatorial and apparatus is only 59*lb.* avoirdupoise, which are contained in a mahogany case.

The principal adjustment in this instrument is that of making the line of collimation to describe a portion of an hour-circle in the heavens; in order to which, the azimuth circle must be truly level, the line of collimation, or some corresponding line, represented by the small brass rod M, parallel to it, must be perpendicular to the axis of its own proper motion; and this last axis must be perpendicular to the polar axis; on the brass rod, M, there is occasionally placed a hanging-level, N, the use of which will appear in the following adjustments: the azimuth circle may be made level, by turning the instrument till one of the levels is parallel to an imaginary line joining two of the feet screws; then adjust that level with these two feet screws; turn the circle half round, *i. e.* 180°; and if the bubble be not then right, correct half the error by the screw belonging to the level, and the half error by the two foot screws; repeat this till the bubble comes right; then turn the circle 90° from the two former positions, and set the bubble right, if it be wrong, by the foot screw at the end of the level; when this is done, adjust the other level by its own screw, and the azimuth circle will be

truly level. The hanging level must then be fixed to the brass rod by two hooks of equal length, and made truly parallel to it: for this purpose make the polar axis perpendicular or nearly perpendicular to the horizon; then adjust the level by the pinion of the declination semicircle; reverse the level, and if it be wrong, correct half the error by a small steel screw that lies under one end of the level, and the other half-error by the pinion of the declination semi-circle; repeat this till the bubble be right in both positions. In order to make the brass rod on which the level is suspended at right angles to the axis of motion of the telescope or line of collimation, make the polar axis horizontal, or nearly so; set the declination semicircle to 0°, turn the hour circle till the bubble comes right; then turn the declination circle to 90°; adjust the bubble by raising or depressing the polar axis (first by hand till it be nearly right, afterwards tighten with an ivory key the socket which runs on the arch with the polar axis, and then apply the same ivory key to the adjusting screw at the end of the said arch till the bubble come quite right); then turn the declination circle to the opposite 90°; if the level be not then right, correct half the error by the aforesaid adjusting screw at the end of the arch, and the other half error by the two screws which raise or depress the end of the brass rod. The polar axis remaining nearly horizontal as before, and the declination semi-circle at 0°, adjust the bubble by the hour-circle; then turn the declination semi-circle to 90°, and adjust the bubble by raising or depressing the polar axis; then turn the hour-circle twelve hours; and if the bubble be wrong, correct half the error by the polar axis, and the other half error by the two pair of capstan screws at the feet of the two supports, on one side of the axis of motion of the telescope; and thus this axis will be at right angles to the polar axis. The next adjustment is to make the centre of cross hairs remain on the same object, while you turn the eye-tube quite round by the pinion of the refraction apparatus: for this adjustment, set the index on the slide to the first division on the dove-tail; and set the division marked 18″ on the refraction circle to its index; then look through the telescope, and with the pinion turn the eye-tube quite round; and if the centre of the hairs does not remain on the same spot during that revolution, it must be corrected by the four small screws, two and two at a time (which you will find upon unscrewing the nearest end of the eye-tube that contains the first eye-glass); repeat this correction till the centre of the hairs remain on the spot you are looking at during an entire revolution.

In order to make the line of collimation parallel to the brass rod on which the level hangs, set the polar axis horizontal, and the declination circle to 90°, adjust the level by the polar axis; look through the telescope on some distant horizontal object, covered by the centre of the cross hairs; then invert the telescope, which is done by turning the hour-circle half round; and if the centre of the cross hairs does not cover the same object as before, correct half the error by the uppermost and lowermost of the four small screws at the eye-end of the large tube of the telescope; this correction will give a second object, now covered by the centre of the hairs, which must be adopted instead of the first object: then invert the telescope as before; and if the second object be not covered by the centre of the hairs, correct half the error by the same two screws which were used before: this correction will give a third object, now covered by the centre of the hairs, which must be adopted instead of the second object; repeat this operation till no error remains; then set the hour-circle exactly to twelve hours (the declination circle remaining at 90° as before); and if the centre of the cross hairs does not cover the last object fixed on, set it to that object by the two remaining small screws at the eye-end of the large tube, and then the line of collimation will be parallel to the brass rod. For rectifying the nonius of the declination and equatorial circles, lower the telescope as many degrees, minutes, and seconds, below 0° or Æ on the declination semi-circle, as are equal to the complement of the latitude; then elevate the polar axis till the bubble be horizontal, and thus the equatorial circle will be elevated to the co-latitude of the place; set this circle to six hours; adjust the level by the pinion of the declination circle; then turn the equatorial circle exactly twelve hours from the last position; and if the level be not right, correct one half of the error by the equatorial circle, and the other half by the declination circle; then turn the equatorial circle back again exactly twelve hours from the last position; and if the level be still wrong, repeat the correction as before till it be right, when turned to either position; that being done, set the nonius of the equatorial circle exactly to six hours, and the nonius of the declination circle exactly

to 0°. The principal uses of this equatorial are, 1. To find your meridian by one observation only; for this purpose, elevate the equatorial circle to the colatitude of the place, and set the declination semi-circle to the sun's declination for the day and hour of the day required; then move the azimuth and hour circles both at the same time, either in the same or contrary direction, till you bring the centre of the cross hairs in the telescope exactly to cover the centre of the sun; when that is done, the index of the hour circle will give the apparent or solar time at the instant of observation; and thus the time is gained, though the sun be at a distance from the meridian; then turn the hour-circle till the index points precisely at twelve o'clock, and lower the telescope to the horizon, in order to observe some point there in the centre of your glass, and that point is your meridian mark found by one observation only; the best time for this operation is three hours before or three hours after twelve at noon. 2. To point the telescope on a star, though not on the meridian, in full day light. Having elevated the equatorial circle to the co-latitude of the place, and set the declination semi-circle to the star's declination, move the index of the hour circle till it shall point to the precise time at which the star is then distant from the meridian, found in tables of the right ascension of the stars, and the star will then appear in the glass. Besides these uses peculiar to this instrument, it is also applicable to all the purposes to which the principal astronomical instruments, *viz.* a transit, a quadrant, and an equal altitude instrument, are applied. See Vince's "Practical Astronomy."

OBSIDIAN, in mineralogy, a genus of the Pitch-stone family, found in nests in the pearl-stone of Hungary. It is common likewise in Iceland, Siberia, the Levant islands, and in South America, and has obtained the name of the Iceland agate. The principal colour is velvet-black, but it passes into greenish grey. It is often striped and spotted. The specific gravity is about 2.4: it melts into an opaque, grey mass. Specimens have been analysed, and found to contain

Silica	69		74
Alumina	22		2
Oxide of iron	9		14
	100		90
		Loss	10
			100

It is on account of its great hardness and opaque blackness, and of its capability of receiving a high polish used as an ornament in dress. In Peru, before the conquest of the country by Spain, obsidian was used as a mirror, and in Europe it has been fashioned into reflectors for telescopes.

OBTUSE, signifies blunt, dull, &c. in opposition to acute, sharp, &c.; thus we say, obtuse angle, obtuse angled triangle, &c.

OCCIDENT, in geography, the westward quarter of the horizon, or that part of the horizon where the ecliptic, or the sun therein, descends into the lower hemisphere, in contradistinction to orient.

OCCIPITAL, in anatomy, a term applied to the parts of the occiput, or back part of the skull.

OCCULT, something secret, hidden, or invisible. The occult sciences are, magic, necromancy, cabbala, &c.

Occult, in geometry, is used for a line that is scarcely perceivable, drawn with the point of the compasses, or a leaden pencil. These lines are used in several operations, as the raising of plans, designs of building, pieces of perspective, &c. They are to be effaced when the work is finished.

OCCULTATION, in astronomy, the time a star or planet is hidden from our sight, by the interposition of the body of the moon, or of some other planet.

Occultation, *Circle of perpetual,* is a parallel in an oblique sphere, as far distant from the depressed pole, as the elevated pole is from the horizon.

All the stars between this parallel and the depressed pole, never rise, but lie constantly hidden under the horizon of the place.

OCCUPANCY, in law, is a right which one acquires to a thing by being the first to gain possession of it. But this right is now chiefly done away by the English law. Formerly, if a tenant for a term of another's life died, leaving the *cestui que vie;* that is, during the life of the person for whose life the estate was held; he who first entered should hold the land during the other man's life; and he was in law called an occupant, because his title was by his first occupation. But now this title is prevented by the statutes 29 Charles II. c. 3, s. 12, and 14 George II. c. 20, s. 9, which make the estate personal assets devisable, and chargeable with the debts of the deceased, in the hands of the heir, who enters as special occupant.

OCEAN, in geography, that vast collection of salt and navigable waters, in which the two continents, the first including Europe, Asia, and Africa, and the last America, are inclosed like islands. The ocean is distinguished into three grand divisions. 1. The Atlantic Ocean, which divides Europe and Africa from America, which is generally about three thousand miles wide. 2. The Pacific Ocean, or South Sea, which divides America from Asia, and is generally about ten thousand miles over; and 3. The Indian Ocean, which separates the East Indies from Africa, which is three thousand miles over. The other seas, which are called oceans, are only parts or branches of these, and usually receive their names from the countries they border upon. For the saltness, tides, &c. of the ocean, see the articles SEA, TIDES, &c.

OCHRES, in chemistry, combinations of earths with the oxide of iron: they are of various colours, and are principally employed as pigments.

OCHROIT, in chemistry, an earth discovered by Klaproth: the colour of the mineral in which the earth is found, and which is denominated ochroites, is between red and brown. It is compact, and breaks splintering in irregular or angular pieces. It is perfectly opaque, and the powder is of a reddish grey. The specific gravity is about 4.6. The earth was called ochroit, from the Greek word ωχρος, on account of the characteristic property which it possesses of acquiring a light brown colour after being heated. The mineral consists of

Ochroit earth	54.5
Silex	34.
Oxide of iron	4
Water	5
	97.5
Loss	2.5
	100

Ochroit earth is capable of combining with carbonic acid, during its precipitation from acids by carbonated alkalies, and strongly consolidating a portion of water. It is observed in "Nicholson's Journal," that the ochroit earth bears the nearest relation to ittria, and like that, it forms a connecting link between the earths and the metallic oxides. Like ittria, it has the property of forming a reddish-coloured salt with sulphuric acid, and is precipitable by prussiate of potash; but it differs from ittria, in that it does not form sweet salts; that it is not soluble, or at least very sparingly, in carbonate of ammonia; and that, when ignited, it acquires a cinnamon-brown colour. It differs also from ittria, by not being soluble in borax, or phosphate of soda, when urged upon charcoal before the blow-pipe, which salts easily effect a solution of ittria, and melt with it also into a pellucid pearl. See ITTRIA.

OCHNA, in botany, a genus of the Polyandria Monogynia class and order. Natural order of Coadunatæ. Magnoliæ, Jussieu. Essential character: calyx five-leaved; corolla five-petalled; berries one-seeded, fastened to a large, roundish receptacle. There are three species.

OCHROMA, in botany, a genus of the Monadelphia Pentandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three-leaved; anthers connate, anfractuose; capsule five-celled, many-seeded. There is but one species, *viz.* O. lagopus, a large tree, with divaricating branches; the wood is white, tender, and sufficiently light to be used instead of corks for nets; the bark is thick, fibrous, and ash-coloured; leaves frequently a foot and half in diameter; flowers on the upper branchlets, on thick, straight peduncles; calyx greenish red; petals white, fleshy; capsule eight or ten inches long. It is a native of America.

OCHROXYLUM, in botany, a genus of the Pentandria Trigynia class and order. Essential character: calyx five-cleft; petals five; nectary an annular three-lobed gland; capsule three, approximating, one-celled, two-seeded.

OCIMUM, in botany, *basil*, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: calyx with the upper lip orbiculate, the lower four-cleft; corolla resupine, with one lip four-cleft, the other undivided; filaments, the two outer putting forth a reflex process at the base. There are twenty-five species; these are either herbs or under shrubs, possessing a sweet scent; their flowers are in whorls, forming a loose spike, terminating and axillary.

OCTAGON, in geometry, is a figure of eight sides and angles: and this, when all the sides and angles are equal, is called a regular octagon, or one which may

be inscribed in a circle. If the radius of a circle, circumscribing a regular octagon, be $= r$, and the side of the octagon $= y$, then $y = \sqrt{2r^2 - r\sqrt{2r^2}}$.

Octagon, in fortification, denotes a place that has eight bastions.

OCTAHEDRON, or Octaedron, in geometry, one of the five regular bodies, consisting of eight equal and equilateral triangles. See the article Body. The square of the side of the octahedron is to the square of the diameter of the circumscribing sphere, as 1 to 2. If the diameter of the sphere be 2, the solidity of the octahedron inscribed in it will be 1.33333, nearly. The octahedron is two pyramids put together at their bases, therefore its solidity may be found by multiplying the quadrangular base of either of them, by one-third of the perpendicular height of one of them, and then doubling the product.

OCTANDRIA, in botany, the eighth class in Linnæus's system, consisting of plants with hermaphrodite flowers, which are furnished with eight stamina or male organs of generation. There are four orders belonging to this class of plants, which derive their names from the number of female organs possessed by the plants of each respective division.

OCTANT, or *Octile*, in astronomy, that aspect of two planets, wherein they are distant an eighth part of a circle, or 45° from each other.

OCTAVE, in music, an harmonical interval, consisting of seven degrees, or lesser intervals. See Music.

OCTOBER, in chronology, the tenth month of the Julian year, consisting of thirty-one days: it obtained the name of October from its being the eighth month in the calendar of Romulus. See the articles Month and Year.

ODE, in poetry, a song, or a composition proper to be sung. Among the ancients odes signified no more than songs; but with us they are very different things. The ancient odes were generally composed in honour of their gods, as many of those of Pindar and Horace. These had originally but one stanza, or strophe, but afterwards they were divided into three parts, the strophe, the antistrophe, and the epode. The priests going round the altar singing the praises of the gods, called the first entrance, when they turned to the left, the strophe; the second, turning to the right, they called antistrophe, or returning; and, lastly, standing before the altar, they sung the remainder, which they called the epode.

OECUMENICAL, signifies the same with general, or universal; as oecumenical council, bishop, &c.

OEDERA, in botany, a genus of the Syngenesia Polygamia Segregata class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferiæ, Jussieu. Essential character: calyxes many-flowered; corrollets tubular, hermaphrodite with one or two female ligulate florets; receptacle chaffy; down of several chaffs. There are two species, *viz.* O. prolifera, and O. aliena, both natives of the Cape of Good Hope.

OENANTHE, in botany, *dropwort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: florets difform; in the disk sessile, barren; fruit crowned with the calyx and pistil. There are eleven species; of which O. crocata, hemlock water dropwort, commonly grows four or five feet high, with strong jointed stalks, which being broken emit a yellowish fetid juice; the leaves are similar to those of hemlock, but of a lighter green colour; the roots divide into four or five larger taper ones, having some resemblance to parsneps, for which they have been taken. It grows naturally in several parts of Europe, on the banks of ditches, rivers, and lakes.

OENOTHERA, in botany, *tree primrose*, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Onagræ, Jussieu. Essential character: calyx four-cleft; petals four; capsule cylindrical, inferior; seeds naked. There are eleven species; of which O. biennis, broad-leaved tree primrose, has a fusiform, fibrous root; from this, the first year, arise many obtuse leaves, spreading flat upon the ground; from among these, the second year, come out the stems, three or four feet in height, upright, of a pale green colour; flowers solitary, each being separated by a leaflet, or bracte; they usually open between six and seven o'clock in the evening; for this reason the plant is called evening, or night primrose; the mode of their expanding is curious; the petals are held together at the top by the hooks at the end of the calyx; the segments of which first separate at bottom, discovering the corolla, a long time before it acquires sufficient expansive force to unhook the calyx at top: when it has accomplished this, it expands almost instantaneously to a certain point;

it then makes a stop, taking time to spread out quite flat; it may be half an hour from the first bursting of the calyx at bottom to the final expansion of the corolla, which commonly becomes flaccid in the course of the next day, according to the heat or coolness of the weather; the uppermost flowers appear first in June; the stalks keep continually advancing in height, and there is a constant succession of flowers till late in autumn. It is a native of North America.

OESOPHAGUS, the gula, or gullet, is a membranaceous canal, reaching from the fauces to the stomach, and conveying into it the food taken in at the mouth. Its figure is somewhat like that of a funnel, and its upper part is called by anatomists the pharynx. See ANATOMY.

OESTRUS, in natural history, *gad-fly*, a genus of insects of the order Diptera. Mouth with a simple aperture, and not exserted: feelers two, of two articulations orbicular at the tip, and seated each side in a depression of the mouth: antennæ of three articulations, the last subglobular, and furnished with a bristle on the fore-part, placed in two hollows on the front. The face of this singular genus is broad, depressed, vesicular, and glaucous, and has some sort of resemblance to the ape kind. They are extremely troublesome to horses, sheep, and cattle, depositing their eggs in different parts of the body, and producing very painful tumours, and sometimes death. The larvæ are without feet, short, thick, and annulate, and often furnished with small hooks. There are twelve species, named from the animals which they infest: thus we have O. bovis, O. equi, O. ovis, O. hominis, &c. The principal European species is the O. bovis, or ox gad fly, which is the size of a common bee, and is of a pale yellowish colour, with the thorax marked with four longitudinal dusky streaks, and the abdomen by a black bar across the middle; the lip is covered with tawny orange-coloured hairs; the wings are pale-brown, and unspotted. The female of this species, when ready to deposit her eggs, fastens on the back of a heifer, or cow, and piercing the skin with the tube situated at the tip of the abdomen, deposits an egg in the puncture, and then proceeds to another spot at some distance from the former, repeating the same operation, at intervals, on many parts of the animal's back. The pain which this operation occasions is extreme; and hence cattle, as if foreseeing their cruel enemy, are observed to be seized with the most violent horror when apprehensive of the approaches of the female oestrus, flying instantly to the nearest pond or pool of water; it having been observed that this insect rarely attacks cattle when standing in water. The eggs are laid in August or September, and the larvæ remain till the following summer before they undergo the change to the pupa state. At this period they force themselves out of their respective cells, and falling to the ground, creep beneath the first convenient shelter, and lying in an inert state become contracted into an oval form, but without casting the larva skin, which dries and hardens round them. When the included insect is ready for exclusion, it forces open the top of the pupa coat, and emerges in its perfect form, having remained within the chrysalis somewhat more than a month.

We shall give an account of the O. equi, from the Transactions of the Linnæan Society, drawn up with great accuracy by Mr. Clarke. "When the female has been impregnated, and the eggs are sufficiently mature, she seeks among the horses a subject for her purpose; and approaching it on the wing, she holds her body nearly upright in the air, and her tail, which is lengthened for the purpose, curved inwards and upwards: in this way she approaches the part where she designs to deposit her egg; and, suspending herself for a few seconds before it, suddenly darts upon it, and leaves her egg adhering to the hair: she hardly appears to settle, but merely touches the hair with the egg held out on the projected point of the abdomen. The egg is made to adhere by means of a glutinous liquid secreted with it. She then leaves the horse at a small distance, and prepares a second egg, and, poising herself before the part, deposits it in the same way. The liquor dries, and the egg becomes firmly glued to the hair: this is repeated by various flies, till four or five hundred eggs are sometimes placed on one horse. The horses, when they become used to this fly, and find that it does them no injury, as the Tabani and Conopes, by sucking their blood, hardly regard it, and do not appear at all aware of its insidious object. The skin of the horse is always thrown into a tremulous motion on the touch of this insect, which merely arises from the very great irritability of the skin and cutaneous muscles at this season

of the year, occasioned by the continual teasing of the flies, till at length these muscles act involuntarily on the slightest touch of any body whatever.

"The inside of the knee is the part on which these flies are most fond of depositing their eggs, and the next to this, on the side and back part of the shoulder, and, less frequently, on the extreme ends of the mane. But it is a fact worthy of attention, that the fly does not place them promiscuously about the body, but constantly on those parts which are most liable to be licked with the tongue; and the ova, therefore, are always scrupulously placed within its reach.

"The eggs thus deposited I at first supposed were loosened from the hairs by the moisture of the tongue, aided by its roughness, and were conveyed to the stomach, where they were hatched: but on more minute search I do not find this to be the case, or at least only by accident; for, when they have remained on the hairs four or five days they become ripe, after which time the slightest application of warmth and moisture is sufficient to bring forth, in an instant, the latent larva. At this time, if the tongue of the horse touches the egg, its operculum is thrown open, and a small active worm is produced, which readily adheres to the moist surface of the tongue, and is from thence conveyed with the food to the stomach. If the egg itself be taken up by accident, it may pass on to the intestinal canal before it hatches; in which case its existence to the full growth is more precarious, and certainly not so agreeable, as it is exposed to the bitterness of the bile.

"I have often, with a pair of scissars, clipped off some hairs with eggs on them from the horse, and on placing them in the hand, moistened with saliva, they have hatched in a few seconds. At other times, when not perfectly ripe, the larva would not appear, though held in the hand under the same circumstances for several hours; a sufficient proof that the eggs themselves are not conveyed to the stomach. It is fortunate for the animal infested by these insects, that their numbers are limited by the hazards they are exposed to. I should suspect near a hundred are lost for one that arrives at the perfect state of a fly. The eggs, in the first place, when ripe, often hatch of themselves, and the larva, without a nidus, crawls about till it dies; others are washed off by water, or are hatched by the sun and moisture thus supplied together. When in the mouth of the animal they have the dreadful ordeal of the teeth and mastication to pass through. On their arrival at the stomach, they may pass mixed with the mass of food into the intestines; and when full grown, in dropping from the animal to the ground, a dirty road or water may receive them. If on the commons, they are in danger of being crushed to death, or of being picked up by the birds who so constantly attend the footsteps of the cattle for food. Such are the contingencies by which nature has wisely prevented the too great increase of their numbers, and the total destruction of the animals they feed on.

"I have once seen the larva of this œstrus in the stomach of an ass; indeed there is little reason to doubt their existence in the stomachs of all this tribe of animals. These larvæ attach themselves to every part of the stomach, but are generally most numerous about the pylorus, and are sometimes, though much less frequently, found in the intestines. Their numbers in the stomach are very various, often not more than half a dozen, at other times more than a hundred; and, if some accounts might be relied on, even a much greater number than this. They hang most commonly in clusters, being fixed by the small end to the inner membrane of the stomach, which they adhere to by means of two small hooks, or tentacula. When they are removed from the stomach they will attach themselves to any loose membrane, and even to the skin of the hand. The body of the larva is composed of eleven segments, all of which, except the two last, are surrounded with a double row of horny bristles, directed towards the truncated end, and are of a reddish colour, except the points, which are black. The larvæ evidently receive their food at the small end, by a longitudinal aperture, which is situated between two hooks, or tentacula. Their food is probably the chyle, which, being nearly pure aliment, may go wholly to the composition of their bodies, without any excrementitious residue, though on dissection the intestine is found to contain a yellow or greenish matter, which is derived from the colour of the food, and shows that the chyle, as they receive it, is not perfectly pure. They attain their full growth about the latter end of May, and are coming fron the horse from this time to the latter end of June, or sometimes later. On dropping to the ground

they find out some convenient retreat, and change to the chrysalis; and in about six or seven weeks the fly appears.

"The perfect fly but ill sustains the changes of weather; and cold and moisture, in any considerable degree, would probably be fatal to it. These flies never pursue the horse into the water. This aversion I imagine arises from the chillness of that element, which is probably felt more exquisitely by them, from the high temperature they had been exposed to during their larva state. The heat of the stomach of the horse is much greater than that of the warmest climate, being about 102 degrees of Fahrenheit, and in their fly state they are only exposed to 60, and from that to about 80 degrees. This change, if suddenly applied, would in all probability be fatal to them; but they are prepared for it, by suffering its first effects in the quiescent and less sensible state of a chrysalis. I have often seen this fly, during the night time and in cold weather, fold itself up with the head and tail nearly in contact, and lying apparently in a torpid state through the middle of the summer."

O. ovis: wings pellucid, punctured at the base; abdomen variegated with white and black. It deposits its eggs on the inner margin of the nostrils of sheep, occasioning them to shake their heads violently, and hide their noses in the dust or gravel. The larva crawl up into the frontal sinuses, and when full fed are again discharged through the nostrils. See Pl. III. Entomology, fig. 7 and 8.

OFFENCE, is any act committed against any law. Offences are either capital, or not capital. Capital offences are those for which the offender loses his life; not capital, where the offender may lose his lands and goods, be fined, or suffer corporal punishment, or both, but which are not subject to the loss of life.

OFFERINGS. Oblations and offerings partake of the nature of tithes; and all persons, who by law ought to pay their offerings, shall yearly pay to the parson, vicar, proprietary, or their deputies, or farmers of the parishes where they dwell, at such four offering days as heretofore within the space of four years last past hath been accustomed, and in default thereof shall pay for the said offerings at Easter following.

OFFICE, is that function, by virtue of which a person has some employment in the affairs of another. An office is a right to exercise any public or private employment, and to take the fees and emoluments belonging to it, whether public, as those of magistrates; or private, as of bailiffs, receivers, &c.

The statute 5 and 6 Edward VI. c. 16, declares all securities given for the sale of offices unlawful. And if any person shall bargain, or sell, or take any reward, or promise of reward, for any office, or the deputation of any office, concerning the revenue, or the keeping of the king's castles, or the administration and execution of justice, unless it be such an office as had been usually granted by the justices of the King's Bench, or Common Pleas, or by justices of assize, every such person shall not only forfeit his right to such office, or to the nomination thereof; but the person giving such reward, &c. shall be disabled to hold such office.

But it has been decided, that where an office is within the statute, and the salary certain, if the principal make a deputy, reserving by bond a less sum out of the salary, it is good: or if the profits are uncertain, reserving a part, as half the profits, it is good; for the fees still belong to the principal, in whose name they must be sued for. But where a person so appointed gives a bond to the principal to pay him a sum certain, without reference to the profits, this is void under the statute.

To offer money to any officer of state, to procure the reversion of an office in the gift of the crown, is a misdemeanor at common law, and punishable by information; and even the attempt to induce him, under the influence of a bribe, is criminal, though never carried into execution. An instance of which occurred under the administration of Mr. Addington, who prosecuted a tinman for offering a sum of money to him for a place in the customs.

Any contract to procure the nomination to an office, not within the statute 6 Edward VI. is defective, on the ground of public policy; and the money agreed to be given is not recoverable.

OFFICER, a person possessed of a post or office.

The great officers of the crown, or state, are the Lord High Steward, the Lord High Chancellor, the Lord High Treasurer, the Lord President of the Council, the Lord Privy Seal, the Lord Chamberlain, the Lord High Constable, the Earl Marshal: each of which see under its proper article.

OFFICERS, *commission*, are those appointed by the King's commission: such are all from the general to the cornet in-

clusive, who are thus denominated in contradistinction to warrant officers, who are appointed by the colonel's or captain's warrant, as quarter-masters, sergeants, corporals, and even chaplains and surgeons.

Officers, *field*, are such as command a whole regiment, as the colonel, lieutenant-colonel, and major.

Officers, *general*, are those whose command is not limited to a single company, troop, or regiment; but extends to a body of forces, composed of several regiments: such are the general, lieutenant-general, major-generals, and brigadiers.

Officers, *staff*, are such as, in the King's presence, bear a white staff, or wand; and at other times, on their going abroad, have it carried before them by a footman, bare-headed: such are the Lord Steward, Lord Chamberlain, Lord Treasurer, &c.

The white staff is taken for a commission, and at the king's death each of these officers breaks his staff over the hearse made for the king's body, and by this means lays down his commission, and discharges all his inferior officers.

Officers, *subaltern*, are all who administer justice in the name of subjects: as those who act under the Earl Marshal, Admiral, &c. In the army the subaltern officers are the lieutenants, cornets, ensigns, sergeants, and corporals.

OFFICIAL, by the ancient law, signifies him who is the minister of, or attendant upon, a magistrate. In the canon law, it is especially taken for him to whom any bishop generally commits the charge of his spiritual jurisdiction; and in this sense there is one in every diocese called *officialis principalis*, whom the laws and statutes of this kingdom call chancellor. 32 Hen. VIII. 15.

OFFING, or Offin, in the sea-language, that part of the sea a good distance from shore, where there is deep water, and no need of a pilot to conduct the ship: thus, if a ship from shore be seen sailing out to seaward, they say, she stands for the offing: and if a ship, having the shore near her, have another a good way without her, or towards the sea, they say, that ship is in the offing.

OFF-SETS, in gardening, are the young shoots that spring from the roots of plants; which being carefully separated, and planted in a proper soil, serve to propagate the species.

Off-sets, in surveying, are perpendiculars let fall, and measuring from the stationary lines to the hedge, fence, or extremity of an enclosure.

OGEE, or O. G., in architecture, a moulding, consisting of two members, the one concave, and the other convex; or, of a round and a hollow, like an S.

OGIVE, in architecture, an arch, or branch of a Gothic vault; which instead of being circular, passes diagonally from one angle to another, and forms a cross with the other arches.

OIL. The general character of oils are combustibility, insolubility in water, and fluidity. From the peculiar properties of different oils, they are naturally divided into two kinds; fixed or fat oils, and volatile or essential oils. The fixed, or fat oils, require a high temperature to raise them to the state of vapour, a temperature above that of boiling water; but the volatile, or essential oils, are volatilized at the temperature of boiling water, and even at a lower one. Both the volatile and fixed oils are obtained from plants, and sometimes from the same plant; but always from different parts of it. While the seeds yield fixed oil, the volatile oil is extracted from the bark or wood. One of the most distinguishing characteristics of the fixed oils is, that they exist only in one part of the vegetable, in the seeds. No trace of fixed oil can be detected in the roots, the stem, leaves, or flowers of those plants, whose seeds afford it in great abundance. The olive may seem an exception to this. The oil which it yields is extracted, not from the seeds, but from its covering. Among plants too, fixed oils are only found existing in those whose seeds have a peculiar structure. The seeds of plants have sometimes one lobe, in which case they are called "monocotyledonous" plants; and sometimes they have two, when they are denominated "dicotyledonous." The formation of fixed oil in plants is exclusively limited to the latter class. There is no instance of fixed oils being found in the seeds of plants which have only one lobe. Those seeds which yield the fixed oils contain also a considerable portion of mucilage, so that when such seeds are bruised and mixed with water, they form what is called an emulsion, which is a white fluid, containing a quantity of the oil of the seed mixed with the mucilage. Fixed oils are extracted from the seeds of a great number of plants. Those which yield it in greatest abundance are, the olive, thence called olive oil; the seeds of lint, and the kernels of almonds, called linseed, or almond oil. Fixed oils

are also obtained from animals; such as train oil, as it is called, which is extracted from the fat or blubber of the whale. Fixed oil is obtained also in great abundance from the liver of animals, and is found to exist in the eggs of fowls. These different kinds of fixed oils, although they possess many common properties, yet in others they are very different. Many of the vegetable oils have no smell, and scarcely any perceptible taste. The animal oils, on the contrary, are generally extremely nauseous and offensive. These differences are supposed to be owing to the mixture of extraneous bodies, or to certain chemical changes which arise from the action of these bodies upon each other, or on the oil itself. As the fixed oils exist ready formed in the seeds of plants, they are generally obtained by "expression," and hence they have been called "expressed oils." This is done by reducing the seeds to a kind of pulp, or paste, which is enclosed in bags, and subjected by means of machinery, when it is obtained in the large way, to strong pressure, so that the oil flows out, and is easily collected. The oil which is obtained by this process, which has been called "cold drawn oil," because it is procured without the application of heat, and merely by pressure, is the purest; but the quantity which seeds in general yield is comparatively small, and some seeds which contain a considerable portion of oil scarcely afford any when treated in this way. It therefore becomes necessary for extracting the oil from seeds of the latter description, and to have it in greater abundance from all seeds, to employ heat to facilitate the separation of the oil from the mucilage, or other matters with which it is combined. For this purpose heat is applied, either to the apparatus which is employed in pressing out the oil, or the bruised seeds are exposed to the vapour of water, and sometimes they are boiled in the water itself; by which means those substances which are soluble in water are separated, and thus the oily part which adhered to these substances is disengaged. The oils which are obtained in this manner are very impure. They are mixed with mucilage, and other parts of the substances from which they have been extracted. Many of these matters separate from the oils when they are left at rest. They are sometimes mechanically purified by filtration through coarse cloths, by which means the grosser parts are separated. Different oils too, it is said, undergo different kinds of purification by different manufacturers, but these processes are kept secret. After they have remained at rest for some time, they are filtered and agitated with water, by which the parts that are soluble in this fluid are separated from the oil. Sometimes they are gently heated, for a shorter or longer time, according to the nature of the substances with which the oil is contaminated. Acids diluted with water are employed to separate the mucilage; lime and the alkalies are also used to combine with an acid which holds this mucilage in solution, and thus to favour its precipitation. Alum, chalk, clay, and ashes, are also employed in the purification of oils.

Fixed oils are generally liquid, but of a thick, viscid consistence, and in general they are lighter than water. The specific gravity varies from 0.91, which is that of olive oil, to 0.94, that of linseed oil. The boiling point of the fixed oils is not under the temperature of 600°. When exposed to cold they congeal, and even crystalize. There is, however, a considerable variety in this respect among fixed oils: some become solid at the temperature of a few degrees above the freezing point of water; while others, on the contrary, require a degree of cold $= 5°$; and some remain fluid when exposed to the greatest cold. Those oils, it has been observed, which most readily become solid, such as olive oil, are least subject to change; while those which congeal with difficulty have a greater tendency to spoil and become rancid. When fixed oil is exposed to heat it does not evaporate, till it is raised to the temperature of boiling, or 600°; but when it is thus raised in vapour its properties are changed. It is decomposed by the separation of some of its principles. The part that is volatilized has a greater proportion of hydrogen; charcoal is deposited, and water and sebacic acid are formed, while carbonated hydrogen gas is disengaged. When oil is exposed to the open air, and a burning body is brought in contact with it, it readily takes fire, and burns rapidly, with a yellowish white flame. It is on this conversion of oil into vapour, and the inflammation of this vapour, that the application of oil in lamps and candles depends. The oil is gradually and in small quantities brought in contact with the burning part of the wick; it is converted into vapour, which is immediately inflamed, and continues to burn till new portions are supplied, to undergo the same change, and thus keep up a constant and uniform light and heat. According

to the analysis of olive oil by Lavoisier, it is composed of hydrogen and carbon, *viz.*

Carbon	78.92
Hydrogen	21.08
	100.00

The fixed oils are insoluble in water. When it is necessary to combine them with this liquid, it is by means of mucilaginous substances, in which case the mixture is known under the name of emulsion; or with alkaline substances, when it is distinguished by the name of soap. Some of these oils become thick, opaque, white, granulated, and are analogous in appearance to tallow. Oils subject to this change are called fat oils; such, for instance, is olive oil, almond oil, and rapeseed oil. This change is more or less rapid in different circumstances. If a thin layer of oil be spread on the surface of the water, and exposed to the air, it takes place in a few days, and this effect is owing to the absorption of oxygen, which combines with the oils. But other oils, when they are exposed to the air, dry altogether, yet have the property of retaining their transparency. Oils which have this peculiar property are called drying oils. The oil of poppies, hemp-seed oil, and particularly linseed oil, are possessed of this property. The nature of the change which takes place in these drying oils is supposed to depend on the absorption of oxygen; and this oxygen combining with the hydrogen of the oil forms water. This opinion is supported by the practice which is followed to increase the drying property of linseed oil. It is usually boiled with litharge, before it is employed by painters. The litharge in this case is partly reduced to the metallic state, by being deprived of its oxygen, which is supposed to combine with the oil. Phosphorus combines with oils, with the assistance of heat. A small portion of the phosphorus is dissolved, which communicates a luminous property to the oils, so that when they are spread upon any surface they shine in the dark. Hence some twenty years ago a person exhibited in London, as the everlasting lamp of the ancients, a vessel containing phosphorus immersed in oil.

The various purposes to which fixed oils are applied, are too well known to require particular enumeration. They are employed in domestic economy, either as articles of food, and for this purpose are used alone, or in combination with other substances; or they are employed for giving light, by being burnt in lamps. They are used in medicine, either on account of the properties which peculiar oils possess, or on account of the properties they communicate to other substances with which they are combined. In this state the use of oils is well known in the form of unguents, plasters, and liniments. In the arts, fixed oils are of the most extensive utility. They are employed in the fabrication of soaps, for mixing colours in painting, for some kinds of varnish, and for defending substances from the action of air and moisture.

Volatile oils are distinguished from the fixed oils by their volatility, fragrance, and acrid taste. They are also known under the name of aromatic oils, from their odour; or essential oils, or simply essences, from being supposed to constitute the essence or the existence of the vegetable matters which furnish them. Volatile oils are not limited to particular parts of plants, but are found to exist in every part of the plant, excepting in the seed, which furnishes the fixed oils. A great number of roots, which are generally distinguished by an aromatic odour, and have more or less of an acrid taste, afford volatile oils. They are furnished also by many woods, such as those of the pine and fir tribe, and by many of those which are natives of warm climates. The leaves of a great number of plants belonging to the Didynamia class also afford volatile oil, as well as many of the umbelliferous plants. It is obtained also from many flowers of vegetables, and also from the covering of many fruits, as the skin of oranges and lemons. It is likewise obtained from a great number of seeds; but it is never found in the cotyledons or lobes themselves, but only in the external covering. The quantity of volatile oil which is obtained from vegetables, varies according to the age, the soil in which they grow, and the state of the plant. Some plants while green furnish it in greatest abundance, while others yield most when they are dry. There are two processes by which volatile oil may be obtained. When it exists in plants in great abundance, and in vesicles in a fluid state, it may be separated by mechanical means. Thus, by simple expression, the volatile oils are extracted from many plants, as, for instance, from the fruit of the orange and the lemon. From the outer rind of these fruits, when they are fresh, the volatile oil is obtained in the liquid form; but in general the volatile oils of plants are neither so abundant, nor do they exist in that state of fluidity, by

which they can be procured by so simple a process. In most cases they are subjected to the process of distillation; and for this purpose they are macerated for some hours in water. They are then introduced into a still with the water; a moderate heat is applied, and continued till the fluid boil, when a great quantity of vapour of water, mixed with the volatile oil, passes over, and is received in proper vessels. The oil collects on the surface of the water, from which it may be easily separated. The water itself is of a milky colour, on account of a small quantity of oil suspended in it; and even after the water becomes transparent by the particles of the oil separating from it, and rising to the top, it is still loaded with the peculiar odour of the plant. The volatile oils are particularly distinguished by their fragrance, which varies in the oils extracted from different plants. The consistence of the volatile oils also varies considerably. Sometimes they are as fluid as water, which is the case with those oils obtained by expression. Some are thick and viscid, as those generally are which are extracted from woods, roots, barks, and fruits of the warmer regions. Some congeal, or assume a granulated solid consistence at different temperatures. Of these last some are always found to be in the concrete state. Several of the volatile oils are susceptible of crystallization, depositing in the remaining portion of the oil, which continues liquid, transparent polyhedrons, more or less of a yellow colour, which are found to be pure oil. This last change is probably owing to an incipient oxydation; for it never takes place unless oils have been kept for some time. There is great variety of colour among volatile oils. Some indeed are nearly colourless, as the oil of turpentine; but in general they are of different shades of colour. Some are yellow, as the oil of lavender; some are of a reddish yellow or brown, as the oil of cinnamon or of rhodium; some are blue, as the oil of chamomile; and some are green, as that of parsley. But the most prevailing colour among volatile oils is yellow or reddish.

Volatile oils have almost always an acrid, hot, and even burning taste. It is observed that the most acrid vegetable matters do not yield an oil possessed of this quality. The specific gravity of volatile oils is generally less than that of water. Some volatile oils, however, as those of sassafras and canella, have a greater specific gravity. The specific gravity of oils varies from 0.87 to 0.99, in those which are lighter than water; but those which are heavier are from 1.03 to 1.40. When volatile oils are exposed to the light, the colour becomes considerably deeper; they become thicker, and increase in specific gravity. When volatile oils are exposed to heat, they evaporate very readily. They are much more combustible than the fixed oils; and in burning give out a great quantity of smoke, a very bright white flame, and a good deal of heat. They require a greater proportion of oxygen than the fixed oils, and yield a greater quantity of water. This arises from a greater proportion of hydrogen, and a smaller quantity of carbon, which they contain. The volatile oils are in some degree soluble in water. When they are agitated with this liquid they combine with it, and communicate a very strong odour, and a slightly acrid taste. Phosphorus and sulphur are soluble in volatile oils. With phosphorus the solution is luminous in the dark, is extremely fetid, and gives out by the force of heat phosphorated hydrogen gas. Some of these oils are employed in medicine. They are used also for the solution of those substances which are to be employed as varnishes; and many of them are used in perfumery. As many of the volatile oils are produced but in small quantity, they are consequently high priced. There is therefore some temptation to adulterate them with fixed oils, with cheaper volatile oils, or with other substances, to increase the quantity. It is therefore of some importance to be able to detect such frauds. When a volatile oil is adulterated with a fixed oil, there is a very easy test to discover it. Let a single drop of the oil that is suspected fall on clean paper, and expose it to a gentle heat. If the oil is pure, the whole will be evaporated, and no trace remain on the paper; but if it has been mixed with a fixed oil, a greasy spot remains behind. Volatile oils are frequently adulterated with oil of turpentine; but this can only be detected by its peculiar odour, which continues for a longer time than most of the other volatile oils. When they are adulterated with alcohol, it is easily detected by mixing a little of the oil with water, which immediately produces a milkiness, by the abstraction of the alcohol from the oil, and its combination with the water. There is another class of oils, known under the name of empyreumatic oils, which have different properties from those which have

been described. These oils are acrid and stimulating, with a strongly fetid and disagreeable odour. It would appear that these properties are owing to a partial decomposition of other oils. These oils are produced, as the name imports, by the action of fire. They are obtained when oils are forced to rise in vapour, and pass over in common distillation, with a greater degree of heat than that of boiling water, or by the application of a strong heat to substances from which no oil was previously extracted. These empyreumatic oils agree in some of their properties with the volatile oils. They combine in small proportion with water, and they are soluble in alcohol; and probably any difference that exists between them is owing to a partial decomposition; for when they are distilled, the oil is restored to a state of purity, and the carbonaceous matter which had been separated remains behind. See Thomson's Chemistry.

OINTMENT. See PHARMACY.

OLAX, in botany, a genus of the Triandria Monogynia class and order. Natural order of Sapotæ, Jussieu. Calyx entire; corolla funnel-form, trifid; nectarium four; berry three-celled, many-seeded. There is but one species, *viz.* O. Zeylanica, a native of Ceylon.

OLD *age*. See LONGEVITY.

OLDENBURG, (HENRY), in biography, who wrote his name sometimes *Grubendol*, reversing the letters, was a learned German gentleman, and born in the duchy of Bremen, in Lower Saxony, about the year 1626, being descended from the counts of Aldenburg in Westphalia: whence his name. During the long English Parliament, in the time of Charles I., he came to England as consul for his countrymen; in which capacity he remained at London in Cromwell's administration. But being discharged of that employment, he was engaged as tutor to Lord Henry O'Bryan, an Irish nobleman, whom he attended to the University of Oxford; and in 1656, he entered himself a student in that university; chiefly to have the benefit of consulting the Bodleian Library. He was afterwards appointed tutor to Lord William Cavendish, and became intimately acquainted with Milton the poet. During his residence at Oxford, he became also acquainted with the members of that society there which gave birth to the Royal Society; and upon the foundation of this latter, he was elected a member of it; and when the society found it necessary to have two secretaries, he was chosen assistant to Dr. Wilkins. He applied himself with extraordinary diligence to the duties of this office, and began the publication of the "Philosophical Transactions," with Number 1, in 1664. In order to discharge this task with more credit to himself and the Society, he held a correspondence with more than seventy learned persons, and others, upon a great variety of subjects, in different parts of the world. This fatigue would have been insupportable, had he not, as he told Dr. Lister, managed it so as to make one letter answer another; and that, to be always fresh, he never read a letter before he was ready immediately to answer it; so that the multitude of his letters did not clog him, nor ever lie upon his hands. Among others, he was a constant correspondent of Mr. Robert Boyle, and he translated many of that ingenious gentleman's works into Latin.

About the year 1674, he was drawn into a dispute with Mr. Hook, who complained, that the Secretary had not done him justice, in the History of the Transactions, with respect to the invention of the spiral spring for pocket-watches: the contest was carried on with some warmth on both sides, but was at length terminated to the honour of Mr. Oldenburg; for, pursuant to an open representation of the affair to the Royal Society, the Council thought fit to declare, in behalf of their Secretary, that they knew nothing of Mr. Hook having printed a book, entitled "Lampas," &c., but that the publisher of the "Transactions" had conducted himself faithfully and honestly in managing the intelligence of the Royal Society, and given no just cause for such reflections.

Mr. Oldenburg continued to publish the "Transactions" as before, to Number 136, June 25, 1677; after which, the publication was discontinued till the January following, when they were again resumed by his successor in the secretary's office, Mr. Nehemiah Grew, who carried them on till the end of February, 1678. Mr. Oldenburg died at his house at Charlton, between Greenwich and Woolwich, in Kent, August 1678, and was interred there, being fifty-two years of age.

He published, besides what has been already mentioned, twenty tracts, chiefly on theological and political subjects; in which he principally aimed at re-

conciling differences and promoting peace.

OLDENLANDIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: calyx fastened to the pericardium with four awl-shaped teeth at top; corolla one-petalled, four cleft; capsule inferior, two-celled; receptacle free, fastened to the partition by the base only. There are sixteen species.

OLEA, in botany, *olive*, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: corolla four-cleft, with sub-ovate segments; drupe one-seeded. There are seven species, of which the O. longifolia, long-leaved European olive, is chiefly cultivated in the south of France, from which they make the best oil. O. latifolia, broad-leaved European olive, is principally cultivated in Spain, where the trees grow to a much larger size than the preceding; the fruit is nearly the size of a Provence olive, but of a stronger flavour; for which reason it is not so grateful to an English palate. The olive seldom becomes a large tree; two or three stems frequently rise from the same root, from twenty to thirty feet in height, putting out branches almost their whole length, covered with a greyish bark.

The olive, in all ages, has been held in peculiar estimation, as the bounteous gift of Heaven; it is still considered as emblematic of peace and plenty; the great quantity of oil which it produces in some countries, effectually realizes the latter of these blessings. Unripe olives pickled, especially the Provence and Lucca sorts, are to many persons extremely grateful; they are supposed to promote digestion.

OLERON *laws*, laws relating to maritime affairs, and so called, because made when King Richard I. was at the Isle of Oleron, in Aquitaine.

OLFACTORY *nerves*, the first pair of the head; so called from their being the immediate instruments of smelling.

OLIFIANT *gas*, a name given by the Dutch chemists to carburated hydrogen, or heavy inflammable gas. See GAS.

OLIGARCHY, a form of government wherein the administration of affairs is lodged in the hands of a few persons. See GOVERNMENT.

OLIVE. See OLEA.

OLIVINE, in mineralogy, a species of the Chrysolite family, found in the form of crystals, chiefly in basalt; colour between asparagus and olive-green; specific gravity 3.2. It is infusible before the blow-pipe; but with borax it melts into a dark-green bead. Nitric acid dissolves its iron, and deprives it of colour. It is found very abundantly in many parts of Germany; also in France, Norway, and Sweden, and in our country: according to Klaproth, it contains

Silica	48
Magnesia	37
Lime	0.25
Oxide of iron	12.5
	97.75
Loss	2.25
	100

OLYRA, in botany, a genus of the Monoecia Triandria class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: male, calyx glume one-flowered, awned; corolla glume awnless. Female, calyx glume one-flowered, spreading, ovate; style bifid; seed cartilaginous. There are two species, *viz.* O. paniculata, and O. pauciflora, both natives of Jamaica.

OMENTUM, the *cawl*, in anatomy, a membranaceous part, usually furnished with a large quantity of fat; being placed under the peritonæum, and immediately above the intestines. See ANATOMY.

OMNIUM, a term in familiar use among stock-brokers and speculators in the funds, to express the whole of the articles which the subscribers to a loan receive from government. Thus if the subscribers, according to their agreement with government, are to have for every hundred pounds advanced a certain sum in 3 per cent. consols, a further sum in 4 per cents, and a proportion of the long annuities, the blank receipts which they receive for making the instalments on the several articles, are, when disposed of independent of each other, as the 3 per cent. consols only, called scrip, but when the receipts are sold together as originally received, they are usually called omnium. As the omnium of every loan is the subject of extensive speculations, it generally is liable to considerable variations with respect to its current price, sometimes selling at a high premium, at other times at a dis-

count, according to the circumstances which take place between the agreement for the loan and the day fixed for paying the last instalment. Thus the omnium of the year 1799, was at first at 4 and 5 per cent. premium; on the 20th of August it had risen to 19¾, and on the 3d September was at 22¼; it soon after fell considerably, and on the 14th of October was at 4½, 2¼, 3¾; but on the 18th November it had got up again to 12 per cent. premium. The omnium of the year 1801 rose, on the signing of preliminaries of peace, to 18 per cent., and was soon after at 25 per cent. premium: the omnium of the following year was at one time at 12 per cent. discount.

OMPHALEA, in botany, a genus of the Monoecia Monadelphia class and order. Natural order of Tricoccæ. Euphorbiæ, Jussieu. Essential character: male, calyx four-leaved; corolla none; filaments columnar, with the anthers inserted into it: female, calyx five-leaved; corolla none; stigma trifid; capsule fleshy, three-celled; nut solitary. There are four species, all natives of Jamaica.

ONCHIDIUM, in natural history, a genus of the Vermes Mollusca class and order. Body oblong, creeping, flat beneath, mouth placed before; two feelers, situate above the mouth; two arms at the side of the head; vent behind and placed beneath. There is but a single species, *viz.* O. typhæ, the onch, which is described in the transactions of the Linnæan society. It inhabits Bengal, on the leaves of the typha elephantina, about an inch long, and not quite so broad, but linear, and longer when creeping. In appearance it very much resembles a limax, but differs principally in wanting the shield and lateral pore, and in being furnished with a vent behind. Body above convex; head small and placed beneath, which when the animal is in motion is perpetually changing its form and size, and drawn in when at rest; mouth placed lengthways and continually varying its shape from circular to linear; feelers retractile, resembling those of the slug, and apparently tipt with eyes; arms dilatable, solid, compressed, and palmate when fully expanded.

ONION, in botany, see ALLIUM. Considered chemically it may be observed, that as it possesses most of the properties of GARLIC (which see) though not in so large proportions, a volatile oil, on which its activity depends, might be expected, but this has not been found. Water distilled from it yields no oil; if therefore there is any oil, it must be in very small quantities and soluble in water. The active principle of the onion acts upon the tin of the alembic in which experiments have been made.

ONISCUS, in natural history, a genus of insects of the order Aptera. Jaw truncate denticulate; lip bifid; antennæ from two to four, setaceous; body oval, consisting of about fourteen transverse segments; fourteen legs. These insects feed on animal and vegetable matter, and they cast their skin. There are nearly fifty species divided into sections. A. without feelers; four antennæ, sessile. B. feelers unequal, the hind-ones longer; antennæ filiform. The most common species is the O. asellus, or common woodlouse, found in great quantities under the bark of decayed trees, beneath stones in damp situations. It preys on minuter insects. O. armadillo, the medical woodlouse, is of a darker colour than the former, but found in similar situations. When suddenly disturbed or touched, it rolls itself up into a round form in the manner of the armadillos; frequently remaining in that state for a considerable length of time. This insect was formerly considered as a specific in many disorders, but is now rarely used. Among marine insects of this genus, is the O. guadeloupensis, measuring about one inch and three quarters in length; antennæ very short, compressed, inferior pair rather longer; abdomen covered with six scales, beneath; tail somewhat ovate, flat, furnished with a lateral style on each side, the last joint of which is bifid; the five segments of the body before the tail are much narrowed, and destitute of feet. The female protects her young, for a considerable time after their exclusion, under the abdominal scales; in this respect resembling the opossum amongst the quadrupeds. They are often found in the mouth of the Clupea menhaden or mossbanker, attached to the palate, and partaking of its form.

ONOCLEA, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character: capsules under the recurved and contracted pinnules of the frond, resembling pericarps. There are two species, *viz.* O. sensibilis, and O. polypodioides; the former is a native of Virginia, the latter was found by Koenig, in the fissures of the rocks near the top of

the Table Mountain at the Cape of Good Hope.

ONONIS, in botany, *restharrow*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx, five-parted, with linear segments; banner striated; legume turgid, sessile; filaments connate, without a fissure. There are thirty-eight species; these are herbaceous plants or under shrubs; leaves ternate, with the leaflets often serrulate; stipules fastened to the bottom of the petiole; flowers yellow or purple, one or many flowered.

ONOPORDUM, in botany, a genus of the Syngenesia Polygamia Æqualis class and order. Natural order of Compositæ Capitatæ. Cinarocephalæ, Jussieu. Essential character: calyx scales mucronate; receptacle honey combed. There are seven species.

ONOSMA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Asperifoliæ. Borragineæ, Jussieu. Essential character: corolla, bell-shaped, with the throat pervious; seeds four. There are three species.

ONYX. See CHALCEDONY.

OPACITY, in philosophy, a quality of bodies which renders them impervious to the rays of light. It has been supposed that opacity consists in this, that the pores of the body are not all straight. This doctrine, however, is deficient: for though to have a body transparent, its pores must be straight, or rather open every way; yet it is inconceivable how it should happen, that not only glass and diamonds, but even water, whose parts are so very moveable, should have all their pores open and pervious every way; while the finest paper, or the thinnest gold leaf, should exclude the light, for want of such pores.

So that another cause of opacity must be sought for. Now all bodies have vastly more pores or vacuities than are necessary for an infinite number of rays to pass freely through them in right lines, without striking on any of the parts themselves. For since water is nineteen times lighter or rarer than gold; and yet gold itself is so very rare that magnetic effluvia pass freely through it, without any opposition, and quicksilver is readily received within its pores, and even water itself by compression, it must have more pores than solid parts; consequently water must have at least forty times as much vacuity as solidity. The cause, therefore, why some bodies are opaque, does not consist in the want of rectilinear pores, pervious every way, but either in the unequal density of the parts, or in the magnitude of the pores, and their being either empty, or filled with a different matter; by means of which the rays of light, in their passage, are arrested by innumerable refractions and reflections, till at length falling on some solid part, they become quite extinct, and are utterly absorbed. Hence cork, paper, wood, &c. are opaque; while glass, diamonds, &c. are pellucid. For in the confines or joining of parts alike in density, such as those of glass, water, diamonds, &c. among themselves, no refraction or reflection takes place, because of the equal attraction every way; so that such of the rays of light as enter the first surface, pass straight through the body, excepting such as are lost and absorbed, by striking on solid parts; but in the bordering of parts of unequal density, such as those of wood and paper, both with regard to themselves, and with regard to the air, or empty space in their larger pores, the attraction being unequal, the reflections and refractions will be very great; and thus the rays will not be able to pass through such bodies, being continually driven about, till they become extinct.

That this interruption or discontinuity of parts is the chief cause of opacity, Sir Isaac Newton argues, appears from hence, that all opaque bodies immediately begin to be transparent, when their pores become filled with a substance of nearly equal density with their parts. Thus, paper, dipped in water or oil, some stones steeped in water, linen cloth dipped in oil or vinegar, &c. become more transparent than before.

OPAL, in mineralogy, a species of the Quartz family, found in many parts of Europe, especially in Hungary. When first dug out of the earth it is soft, but it hardens and diminishes in bulk by exposure to the air. The specific gravity varies from 1.9 to 2.5. There are four subspecies, *viz.* the precious, the common, the semi, and the wood opal. Some specimens have the property of emitting various coloured rays, with a particular effulgency when placed between the eye and the light. The opals that possess this property are distinguished by lapidaries by the epithet oriental or nobilis. It is esteemed the most beautiful of the gems by Eastern nations; but in Europe it is not quite so highly valued on account of its liability to

split on a sudden change of temperature: it is principally used for necklaces, ear-rings, and finger-rings. The most beautiful opals known are in the Imperial cabinet of Vienna; one is five inches long and two and a half in diameter: another is of the size and nearly of the shape of a hen's egg. The noble opal consists of silica and water in the proportion of 9 to 1. Specimens of the common and semi-opal have been analysed and found to consist as follows:

	Common Opal.	Semi Opal.
Silica	98.75	43.50
Alumina	0.1	0.0
Oxide of iron	0.1	47.
Water	0.0	7.5
	98.95	98.00
Loss	1.05	2
	100	100

OPATRUM, in natural history, a genus of insects of the order Coleoptera. Antennæ moniliform, thicker towards the tip; head projecting from a cavity in the thorax; thorax a little flattened, margined; shells immarginate, longer than the abdomen. There are twenty-eight species, O. sabulosum, is brown, shells with three indented raised lines; thorax emarginate. Inhabits Europe and America, on sand.

OPERA, a dramatic composition set to music, and sung on the stage, accompanied with musical instruments, and enriched with magnificent dresses, machines, and other decorations.

OPERA-*glass*, in optics, so called from its use in theatres, &c. it is sometimes called a "diagonal perspective" from its construction. It consists of a tube about four inches long, in each side of which there is a hole exactly against the middle of a plane mirror, which reflects the rays falling upon it to the convex glass, through which they are refracted to the concave eye-glass, whence they emerge parallel to the eye at the hole in the tube. This instrument is not intended to magnify objects more than about two or three times. The peculiar artifice is to view a person at a small distance, so that no one shall know who is observed: for the instrument points to a different object from that which is viewed; and as there is a hole on each side, it is impossible to know on which hand the object is situated, which you are looking at.

OPERCULARIA, in botany, a genus of the Tetrandria Monogynia class and order. Essential character: flower compound; calyx common, one-leafed, unequally toothed, closed by a common receptacle, flowering above, seeding below, falling when ripe. There are three species.

OPHIDIUM, in natural history, a genus of fishes of the order Apodes. Generic character: the head rather naked; teeth in the jaws, palate, and throat; gill membrane seven-rayed; body in the form of a sword. There are four species. We shall notice only O. barbatum, or the bearded Ophidium: this is generally about eight inches long, and is a native of the Adriatic and Mediterranean Seas, and is not much valued as food. It subsists on small fishes and crabs.

OPHIOGLOSSUM, in botany, *adder's tongue*, a genus of the Cryptogamia Filices class and order. Natural order of Filices, or Ferns. Generic character: capsules numerous, connected by a membrane into a distich spike, subglobular, when ripe opening transversely, without any elastic ring; seeds very many, extremely minute. There are nine species.

OPHIORHIZA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Stellatæ. Gentianæ, Jussieu. Essential character: corolla funnel-form; germ bifid; stigmas two; fruit two-lobed. There are three species.

OPHIOXYLUM, in botany, *serpentine wood*, a genus of the Polygamia Monoecia class and order. Natural order of Apocineæ, Jussieu. Essential character: hermaphrodite, calyx five-cleft; corolla five-cleft, funnel-form; stamens five; pistil one: male calyx bifid; corolla five-cleft, with a funnel-form mouth; nectary cylindric; stamens two. There is but one species; *viz.* O. serpentinum, scarlet-flowered ophioxylum, a native of the East Indies.

OPHIRA, in botany, a genus of the Octandria Monogynia class and order. Natural order of Onagræ, Jussieu. Essential character: involucre two-valved, three-flowered; corolla four-petalled, superior; berry one-celled. There is but one species; *viz.* O. stricta, a native o Africa.

OPHRYS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary somewhat keeled underneath. There are thirty-four species. These plants are of the same natural ge-

nus with the Orchis. Linnæus distinguished this natural order into genera from the nectarium, which in Orchis forms a horn or spur at the back of the flower, whereas the lip of it in this is a petal, hanging down, with a ridge or keel running along the back. O. nidis avis, bird's nest Ophrys, has the root composed of many strong fibres, from which arise two oval veined leaves, jointed at their base; between these spring up a naked stalk, about eight inches in height, terminated by a loose spike of herbaceous flowers, resembling gnats, composed of five petals, with a long bifid lip to the nectarium, a crest or standard above, and two wings on the side; capsule angular, opening in six parts, filled with small seeds like dust. Native of several parts of Europe.

OPHTHALMIA, in medicine, an inflammation of the membranes which invest the eye.

OPIUM, in chemistry and medicine, an inspissated gummy juice, which is obtained from the head of the "papaper somniferum." It is imported from Persia, Arabia, and other warm parts of Asia, in flat cakes, covered with leaves to prevent their sticking together. It has a reddish brown colour, and strong peculiar smell: its taste at first is nauseous and bitter; but this soon becomes acrid, and produces a slight warmth in the mouth. A peculiar substance has been detected in opium, to which it is supposed the properties it possesses of producing sleep are owing. On account of this property, this substance has receiyed the name of narcotic matter. It is obtained from the milky juices of some plants, as those of the poppy, lettuce, and some others. Opium, which is extracted from the poppy, is prepared by the following process. The heads of the white poppy, which is cultivated in different countries of the east for this purpose, are wounded with a sharp instrument; a milky juice flows out, which concretes, and is collected and formed into cakes. In this state opium is a tenacious substance, of a brownish colour; has a peculiar smell, and a disagreeable bitter taste. It becomes soft with a moderate heat. It readily takes fire, and burns rapidly. By the analysis of opium, it appears to be composed of the sulphates of lime and of potash, extractive matter, gluten, mucilage, resinous matter, and an oil, besides the narcotic matter, to which its peculiar properties are owing. By digesting opium in water, part of it is dissolved, and by evaporating the solution to the consistence of syrup, a gritty precipitate appears, which becomes more copious with the addition of water. This precipitate is composed of resinous and extractive matter, besides the peculiar narcotic matter which is crystallized. When alcohol is digested on this precipitate, the resinous and narcotic matters are dissolved, and the extractive matter remains behind. As the solution cools, the narcotic matter crystallizes; but the crystals are coloured with a portion of resin. By repeated solutions and crystallizations it may be obtained tolerably pure. If alcohol be digested on the residuum, it becomes of a deep red colour, the same crystals are deposited on cooling, and may be purified in the same way from the resinous matter with which they are contaminated. The narcotic matter, when properly purified, is of a white colour; crystallizes in right-angled prisms, with a rhomboidal base; and has neither taste nor smell. It is insoluble in cold water, and requires 400 parts of boiling water for its solution, from which it is precipitated by cooling. The solution does not redden the tincture of turnsole. It is soluble in 24 parts of boiling alcohol, and requires about 100 parts when it is cold. When water is added to the solution in alcohol, it is precipitated in the form of a white opaque matter. One of the most decided characters of this substance is its easy solubility in all the acids, and without the aid of heat. It is precipitated from these solutions by means of an alkali, in the form of white powder. Pure alkalies increase the power of its solubility in water, and the acids, when not added in excess, occasion a precipitate. When nitric acid is poured on the crystals reduced to a coarse powder, it communicates to them a red colour, and readily dissolves them. When the solution is heated and evaporated, it yields crystals of oxalic acid in considerable quantity. The residuum has a very bitter taste. From the effects of heat and of nitric acid on this substance, it appears to be composed of oxygen, hydrogen, carbon, and azote. This narcotic substance is also found in the milky juice, and in the extracts which are obtained from several other plants, as from different species of lactuca, or lettuce; hyoscyamus niger, or henbane. The leaves of some plants also produce similar effects, as those of the deadly night-shade, fox-glove, and conium maculatum, or hemlock. See Poppy.

OPOPANAX. See GUM *resin*.

OPOSSUM. See DIDELPHIS.

OPTICS, the science of vision, including Catoptrics and Dioptrics, and even Perspective; as also the whole doctrine of light and colours, and all the phenomena of visible objects. See PERSPECTIVE.

Optics, in its more extensive acceptation, is a mixed mathematical science, which explains the manner in which vision is performed in the eye; treats of sight in general; gives the reasons of the several modifications or alterations which the rays of light undergo in the eye; and shows why objects appear sometimes greater, sometimes smaller, sometimes more distinct, sometimes more confused, sometimes nearer, and sometimes more remote. In this extensive signification it is considered by Sir Isaac Newton, in his Optics. Indeed optics make a considerable branch of natural philosophy; both as it explains the laws of nature, according to which vision is performed, and as it accounts for abundance of physical phenomena, otherwise inexplicable.

The reflection of the rays of light is, indeed, an occurrence too frequent and obvious to have escaped the notice even of the earliest observers; a river or some other piece of water was probably the first mirror; its effect was afterward imitated by metallic mirrors: hence was discovered the equality of the angles of incidence and reflection. It was known at an early period that an oar, or other straight piece of wood, partially immersed in water, no longer appeared straight, yet ages after this elapsed before any attempts were made to ascertain the relation between the angles of incidence and refraction. Empedocles was the first person on record that wrote systematically on light; and Euclid composed a treatise on the ancient optics and catoptrics; dioptrics being less known to the ancients, though it was not quite unnoticed by them, for among the phenomena at the beginning of that work, Euclid remarks the effect of bringing an object into view, by refraction, in the bottom of a vessel, by pouring water into it, which could not be seen over the edge of the vessel before the water was poured in; and other authors speak of the then known effects of glass globes, &c. both as burning glasses, and as to bodies seen through them. Euclid's work, the genuineness of which has been doubted, is chiefly on catoptrics, or reflected rays; in which he shows the chief properties of them in plane, convex, and concave surfaces, in his usual geometrical manner, beginning with that concerning the equality of the angles of incidence and reflection, which he demonstrates; and in the last proposition, showing the effect of a concave speculum, as a burning glass, when exposed to the rays of the sun.

The effects of burning glasses, both by refraction and reflection, are noticed by several others of the ancients, and it has been thought that the Romans had a method of lighting their sacred fire by some such means. Aristophanes, in one of his comedies, introduces a person as making use of a globe filled with water to cancel a bond that was against him, by thus melting the wax of the seal. If we give credit to what some ancient historians are said to have written concerning the exploits of Archimedes, we shall be induced to think that he constructed some very powerful burning mirrors. It is even allowed that this eminent geometrician wrote a treatise on the subject of them, though it be not now extant; as also concerning the appearance of a ring or circle under water, and therefore could not have been ignorant of the common phenomena of refraction. We find many questions concerning optical appearances in the works of Aristotle. This author was also sensible that it is the reflection of light from the atmosphere which prevents total darkness after the sun sets, and in places where he does not shine in the day time. He was also of opinion, that rainbows, halos, and mock suns were all occasioned by the reflection of the sun-beams in different circumstances, by which an imperfect image of his body was produced, the colour only being exhibited, and not his proper figure. The ancients were not only acquainted with the more ordinary appearances of refraction, but knew also the production of colours by refracted light. Seneca says, that when the light of the sun shines through an angular piece of glass, it shows all the colours of the rainbow. These colours, however, he says, are false, such as are seen in a pigeon's neck when it changes its position; and of the same nature, he says, is a speculum, which, without having any colour of its own, assumes that of any other body.

It appears also, that the ancients were not unacquainted with the magnifying power of glass globes filled with water, though they probably knew nothing of the reason of this power; and it is supposed that the ancient engravers made use of a glass globe filled with water to

magnify their figures, that they might work to more advantage.

Ptolemy, about the middle of the second century, wrote a considerable treatise on optics. The work is lost; but from the accounts of others it appears that he there treated of astronomical refractions. The first astronomers were not aware that the intervals between stars appear less when near the horizon than in the meridian; and on this account they must have been much embarrassed in their observations; but it is evident that Ptolemy was aware of this circumstance by the caution which he gives to allow something for it, whenever recourse is had to ancient observations. This philosopher also advances a very remote hypothesis, to account for the remarkably great apparent size of the sun and moon when seen near the horizon. The mind, he says, judges of the size of objects by means of a preconceived idea of their distance from us; and this distance is fancied to be greater when a number of objects are interposed between the eye and the body we are viewing, which is the case when we see the heavenly bodies near the horizon. In his Almagest, however, he ascribes this appearance to a refraction of the rays by vapours, which actually enlarge the angle under which the luminaries appear, just as the angle is enlarged by which an object is seen from under water. See PTOLEMY.

Alhazen, an Arabian writer, was the next author of consequence, who wrote about the year 1100. Alhazen made many experiments on refraction, at the surface between air and water, air and glass, and water and glass; and hence he deduced several properties of atmospherical refraction, such as, that it increases the altitudes of all objects in the heavens; and he first advanced that the stars are sometimes seen above the horizon by means of refraction, when they are really below it; which observation was confirmed by Vitellio, Walther, and especially by the observations of Tycho Brahe. Alhazen observed, that refraction contracts the diameters and distances of the heavenly bodies, and that it is the cause of the twinkling of the stars. This refractive power he ascribed, not to the vapours contained in the air, but to its different degrees of transparency. And it was his opinion, that so far from being the cause of the heavenly bodies appearing larger near the horizon, it would make them appear less; observing that two stars appear nearer together in the horizon, than near the meridian. This phenomenon he ranks among optical deceptions. We judge of distance, he says, by comparing the angle under which objects appear, with their supposed distance; so that if these angles be nearly equal, and the distance of one object be conceived greater than that of the other, this will be imagined to be the larger. And he further observes, that the sky near the horizon is always imagined to be further from us than any other part of the concave surface.

In the writings of Alhazen, too, we find the first distinct account of the magnifying power of glasses, and it is not improbable that his writings on this head gave rise to the useful invention of spectacles; for he says, that if an object be applied close to the base of the larger segment of a sphere of glass, it will appear magnified. He also treats of the appearance of an object through a globe, and says that he was the first who observed the refraction of rays into it.

In 1270, Vitellio, a native of Poland, published a treatise on optics, containing all that was valuable in Alhazen, and digested in a better manner. He observes, that light is always lost by refraction, which makes objects appear less luminous. He gave a table of the results of his experiments on the refractive powers of air, water, and glass, corresponding to different angles of incidence. He ascribes the twinkling of the stars to the motion of the air in which the light is refracted; and he illustrates this hypothesis by observing, that they twinkle still more when viewed in water put in motion. He also shows, that refraction is necessary as well as reflection, to form the rainbow; because the body which the rays fall upon is a transparent substance, at the surface of which one part of the light is always reflected, and another refracted. And he makes some ingenious attempts to explain refraction, or to ascertain the law of it. He also considers the foci of glass spheres, and the apparent size of objects seen through them, though with but little accuracy. See REFRACTION.

Contemporary with Vitellio was Roger Bacon, a man of very extensive genius, who wrote upon almost every branch of science; though it is thought his improvements in optics were not carried far beyond those of Alhazen and Vitellio: to him, however, has been attributed the invention of the MAGIC LANTERN, which see.

One of the next who distinguished himself in this way, was Maurolycus, teacher

of mathematics at Messina. In a treatise, "De Lumine et Umbra," published in 1575, he demonstrates, that the crystalline humour of the eye is a lens that collects the rays of light issuing from the objects, and throws them upon the retina, where the focus of each pencil is. From this principle he discovered the reason why some people are short-sighted, and others long-sighted; also why the former are relieved by concave glasses, and the others by convex ones.

Contemporary with Maurolycus was John Baptista Porta, of Naples. He discovered the camera obscura, which throws considerable light on the nature of vision. His house was the constant resort of all the ingenious persons at Naples, whom he formed into what he called An Academy of Secrets, each member being obliged to contribute something that was not generally known, and might be useful. By this means he was furnished with materials for his "Magia Naturalis," which contains his account of the camera obscura, the first edition of which was published, as he informs us, when he was not quite fifteen years old. He also gave the first hint of the magic lantern, which Kircher afterwards followed and improved. His experiments with the camera obscura convinced him, that vision is performed by the intromission of something into the eye, and not by visual rays proceeding from it, as had been formerly imagined; and he was the first who fully satisfied himself and others upon this subject. He justly considered the eye as a camera obscura, and the pupil the hole in the window-shutter; but he was mistaken in supposing that the crystalline humour corresponds to the wall which receives the images; nor was it discovered till the year 1604, that this office is performed by the retina. He made a variety of just remarks concerning vision, and particularly explained several cases in which we imagine things to be without the eye, when the appearances are occasioned by some affection of the eye itself, or by some motion within the eye. He remarked also, that, in certain circumstances, vision will be assisted by convex or concave glasses; and he seems even to have made some small advances towards the discovery of telescopes. Other treatises on optics, with various and gradual improvements, were afterwards successively published by several authors, whose names, with the titles and brief accounts of their general works, would occupy a large space. We must, however, mention the excellent work on optics, by Dr. Smith, 2 vols. 4to.; an abridgment of which was made by Dr. Kipling, for the use of the students at the Universities, entitled, "Elementary Parts of Dr. Smith's Optics," &c. 1778; and an elaborate History of the Present State of Discoveries relating to Vision, Light, and Colours, by Dr. Priestley, 4to. 1772; a work highly instructive and entertaining to persons who have a taste for physics.

The laws of optics depending upon the properties of Light, the reader will do well, as introductory to this article, to refer to what has been said in our fourth volume on that subject. There will be found much curious speculation, and a variety of interesting facts relating to the nature of light, its velocity, and the direction which it takes in moving through free space and through our atmosphere. We shall in this place give a few definitions necessary to the mere student.

By a ray of light, is meant the motion of a single particle; and its motion is represented by a straight line. Any parcel of rays proceeding from a point, is called a pencil of rays. By a medium, is meant any pellucid or transparent body, which suffers light to pass through it. Thus, water, air, and glass, are called media. Parallel rays, are such as move always at the same distance from each other. If rays continually recede from each other, as from C to *c d* (Plate I. Optics, fig. 1.) they are said to diverge. If they continually approach towards each other, as in moving from *c d* to C, they are said to converge. The point at which converging rays meet, is called the focus. The point towards which they tend, but which they are prevented from coming to, by some obstacle, is called the imaginary focus. When rays, after passing through one medium, on entering another medium of different density, are bent out of their former course, and made to change their direction, they are said to be refracted: thus AC (fig. 2), is a ray which, when it enters the medium HGK, instead of proceeding in the same direction CL, it is made to move in the direction CS. When they strike against a surface, and are sent back again from the surface, they are said to be reflected. The incident ray, as AC, is that which comes from any luminous body, and falls upon the reflecting surface, as HK, and CM is the reflected ray. The angle of incidence, is that which is contained between the incident ray AC and a perpendicular to the reflecting surface in the point of reflection, as the angle ACD. The angle of reflection, is that contained

between the said perpendicular DC, and the reflected ray CM, *viz.* the angle DCM. The angle of refraction, is that contained between the refracted ray CS, and the perpendicular CN, *viz.* the angle FCK. The angle of deviation, is that which is contained between the line of direction of an incident ray AL, and the direction of the same ray CF, after it is refracted; thus the angle LCF is the angle of deviation.

A lens, is glass ground into such a form as to collect or disperse the rays of light which pass through it. These are of different shapes, and from thence receive different names. A plano-convex, has one side flat, and the other convex, as A (fig. 3.) A plano-concave, is flat on one side, and concave on the other, as B. A double convex, is convex on both sides, as C. A double concave, is concave on both sides, as D. A meniscus, is convex on one side, and concave on the other, as E. A line passing through the centre of a lens, as F G, is called its axis.

Of Refraction. If the rays of light, after passing through a medium, enter another of a different density perpendicular to its surface, they proceed through this medium in the same direction as before. Thus the ray OP (fig. 2.) proceeds to K, in the same direction. But if they enter obliquely to the surface of a medium, either denser or rarer than what they moved in before, they are made to change their direction in passing through that medium. If the medium which they enter be denser, they move through it in a direction nearer to the perpendicular drawn to its surface. Thus, AC, upon entering the denser medium HGK, instead of proceeding in the same direction AL, is bent into the direction CF, which makes a less angle with the perpendicular OP. On the contrary, when light passes out of a denser into a rarer medium, it moves in a direction farther from the perpendicular. Thus, if SC were a ray of light which had passed through the dense medium HGK, on arriving at the rarer medium it would move in the direction CA, which makes a greater angle with the perpendicular. This refraction is greater or less, that is, the rays are more or less bent or turned aside from their course, as the second medium through which they pass is more or less dense than the first. Thus, for instance, light is more refracted in passing from air into glass, than from air into water; glass being denser than water. And, in general, in any two given media, the sine of any one angle of incidence has the same ratio to the sine of the corresponding angle of refraction, as the sine of any other angle of incidence has to the sine of its corresponding angle of refraction. Hence, when the angle of incidence is increased, the corresponding angle of refraction is also increased; because the ratio of their sines cannot continue the same, unless they be both increased; and if two angles of incidence be equal, the angles of refraction will be equal. The angle of deviation must also vary with the angle of incidence. If a ray of light, A C, (fig. 2) pass obliquely out of air into glass, A D, the sine of the angle of incidence A C D, is to N S, the sine of the angle of refraction N C S, nearly as 3 to 2; therefore, supposing the sines proportional to the angles, the sine of F C L, the angle of deviation, is as the difference between A D and N S, that is as 3—2, or 1, whence the sine of incidence is to the sine of the angle of deviation as 3 to 1. In like manner it may be shewn, that when the ray passes obliquely out of glass into air, the sine of the angle of incidence will be to that of deviation, as N S to A D — N S, that is, as 2 to 1. In passing out of air into water, the sine of the angle of incidence is to that of refraction, as 4 to 3, and to that of deviation, as 4 to 4—3, or 1; and in passing out of water into air, the sine of the angle of incidence is to that of refraction, as 3 to 4, and to that of deviation, as 3 to 1. Hence a ray of light cannot pass out of water into air at a greater angle of incidence than 48° 36′, the sine of which is to radius as 3 to 4. Out of glass into air the angle must not exceed 40° 11′, because the sine of 40° 11′ is to radius as 2 to 3 nearly; consequently, when the sine has a greater proportion to the radius than that mentioned, the ray will not be refracted. It must be observed, that when the angle is within the limit for light to be refracted, some of the rays will be reflected. For the surfaces of all bodies are for the most part uneven, which occasions the dissipation of much light by the most transparent bodies; some being reflected, and some refracted, by the inequalities on the surfaces. Hence a person can see through water, and his image reflected by it at the same time. Hence also, in the dusk, the furniture in a room may be seen by the reflection of a window, while objects that are without are seen through it.

Upon a smooth board, about the centre C, describe a circle H O K P; draw two diameters of the circle, O P, H K, perpendicular to each other; draw A D M

perpendicular to O P; cut off D T and C I equal to three-fourths D A; through T I, draw T I S, cutting the circumference in S; N S drawn from S, perpendicularly upon O P, will be equal to D T, or three-fourths of D A. Then if pins be stuck perpendicularly at A, C, and S, and the board be dipped in the water as far as the line H K, the pin at S will appear in the same line with the pins at A and C. This shews, that the ray which comes from the pin S is so refracted at C, as to come to the eye along the line C A; whence the sine of incidence A D is to the sine of refraction N S, as 4 to 3. If other pins were fixed along C S, they would all appear in A C produced; which shews that the ray is bent at the surface only. The same may be shewn, at different inclinations of the incident ray, by means of a moveable rod turning upon the centre C, which always keep the ratio of the sines A D, N S, as 4 to 3. Also the sun's shadow, coinciding with A C, may be shewn to be refracted in the same manner. The image L, of a small object S, placed under water, is one-fourth nearer the surface than the object. And hence the bottom of a pond, river, &c. is one-third deeper than it appears to a spectator.

To prove the refraction of light in a different way, take an upright empty vessel into a dark room; make a small hole in the window-shutter, so that a beam of light may fall upon the bottom at *a* (fig. 4) where you may make a mark. Then fill the bason with water, without moving it out of its place, and you will see that the ray, instead of falling upon *a*, will fall at *b*. If a piece of looking-glass be laid in the bottom of the vessel, the light will be reflected from it, and will be observed to suffer the same refraction as in coming in; only in a contrary direction. If the water be made a little muddy, by putting into it a few drops of milk, and if the room be filled with dust, the rays will be rendered much more visible. The same may be proved by another experiment. Put a piece of money into the bason when empty, and walk back till you have just lost sight of the money, which will be hidden by the edge of the bason. Then pour water into the bason, and you will see the money distinctly, though you look at it exactly from the same spot as before. See (fig. 2) where the piece of money at S will appear at L. Hence also the straight oar, when partly immersed in water, will appear bent, as A C S.

If the rays of light fall upon a piece of flat glass, they are refracted into a direction nearer to the perpendicular, as described above, while they pass through the glass; but after coming again into air, they are refracted as much in the contrary direction; so that they move exactly parallel to what they did before entering the glass. But, on account of the thinness of the glass, this deviation is generally overlooked, and it is considered as passing directly through the glass.

If parallel rays, *a b* (fig. 1) fall upon a plano convex lens, *c d*, they will be so refracted, as to unite in a point, *c*, behind it; and this point is called the "principal focus," or the "focus of parallel rays;" the distance of which from the middle of the glass, is called the "focal distance," which is equal to twice the radius of the sphere, of which the lens is a portion.

When parallel rays, as A B (fig. 5) fall upon a double convex lens, they will be refracted, so as to meet in a focus, whose distance is equal to the radius or semi-diameter of the sphere of the lens.

Ex. 1. Let the rays of the sun pass through a convex lens into a dark room, and fall upon a sheet of white paper placed at the distance of the principal focus from the lens. 2. The rays of a candle in a room from which all external light is excluded, passing through a convex lens, will form an image on white paper.

But if a lens be more convex on one side than on the other, the rule for finding the focal distance is this: as the sum of the semi-diameters of both convexities is to the semi-diameter of either, so is double the semi-diameter of the other to the distance of the focus; or divide the double product of the radii by their sums, and the quotient will be the distance sought.

Since all the rays of the sun which pass through a convex glass are collected together in its focus, the force of all their heat is collected into that part; and is in proportion to the common heat of the sun, as the area of glass is to the area of the focus. Hence we see the reason why a convex glass causes the sun's rays to burn after passing through it. See Burning *glass*.

All those rays cross the middle ray in the focus *f*, and then diverge from it to the contrary sides, in the same manner as they converged in coming to it. If ano-

ther glass, F G, of the same convexity as D E, be placed in the rays at the same distance from the focus, it will refract them so, as that, after going out of it, they will be all parallel, as *b c*; and go on in the same manner as they came to the first glass, D E, but on the contrary sides of the middle ray. The rays diverge from any radiant point, as from a principal focus; therefore, if a candle be placed at *f*, in the focus of the convex glass F G, the diverging rays in the space F *f* G will be so refracted by the glass, that, after going out of it, they will become parallel, as shewn in the space *c b*. If the candle be placed nearer the glass than its focal distance, the rays will diverge, after passing through the glass, more or less, as the candle is more or less distant from the focus.

If the candle be placed further from the glass than its focal distance, the rays will converge, after passing through the glass, and meet in a point, which will be more or less distant from the glass, as the candle is nearer to, or further from, its focus; and where the rays meet, they will form an inverted image of the flame of the candle; which may be seen on a paper placed in the meeting of the rays.

Hence, if any object, A B C (fig. 6), be placed beyond the focus, F, of the convex glass, *d e f*, some of the rays which flow from every point of the object, on the side next the glass, will fall upon it, and after passing through it, they will be converged into as many points on the opposite side of the glass, where the image of every point will be formed, and consequently the image of the whole object, which will be inverted. Thus the rays, A *d*, A *e*, A *f*, flowing from the point A, will converge in the space, *d a f*, and by meeting at *a*, will there form the image of the point A. The rays, B *d*, B *e*, B *f*, flowing from the point, B, will be united at *b*, by the refraction of the glass, and will there form the image of the point, B. And the rays, C *d*, C *e*, C *f*, flowing from the point, C, will be united at *c*, where they will form the image of the point, C. And so of all the intermediate points between A and C.

If the object, A B C, be brought nearer to the glass, the picture, *a b c*, will be removed to a greater distance; for then, more rays flowing from every single point, will fall more diverging upon the glass; and therefore cannot be so soon collected into the corresponding points behind it. Consequently, if the distance of the object, A B C (fig. 7), be equal to the distance, *e* B, of the focus of the glass, the rays of each pencil will be so refracted by passing through the glass, that they will go out of it parallel to each other; as *d* I, *e* H, *f* h, from the point C; *d* G, *e* K, *f* D, from the point B; and *d* K, *e* E, *f* L, from the point A; and therefore there will be no picture formed behind the glass.

If the focal distance of the glass, and the distance of the object from the glass, be known, the distance of the picture from the glass may be found by this rule, *viz.* multiply the distance of the focus by the distance of the object, and divide the product by their difference; the quotient will be the distance of the picture.

The picture will be as much bigger, or less, than the object, as its distance from the glass is greater or less than the distance of the object: for (fig. 6) as B *e* is to *e b*, so is A C to *c a*; so that if A B C be the object, *c b a* will be the picture; or if *c b a* be the object, A B C will be the picture.

If rays converge before they enter a convex lens, they are collected at a point nearer to the lens than the focus of parallel rays. If they diverge before they enter the lens, they are then collected in a point beyond the focus of parallel rays; unless they proceed from a point on the other side at the same distance with the focus of parallel rays; in which case they are rendered parallel.

If they proceed from a point nearer than that, they diverge afterwards, but in a less degree than before they entered the lens.

When parallel rays, as *a b c d e* (fig. 8), pass through a concave lens, as A B, they will diverge after passing through the glass, as if they had come from a radiant point, C, in the centre of the convexity of of the glass; which point is called the "virtual, or imaginary focus."

Thus, the ray, *a*, after passing through the glass, A B, will go on in the direction, *k l*, as if it had proceeded from the point, C, and no glass been in the way. The ray, *b*, will go on in the direction, *m n*; the ray, *c*, in the direction, *o p*, &c. The ray, C, that falls directly upon the middle of the glass, suffers no refraction in passing through it, but goes on in the same rectilinear direction, as if no glass had been in the way.

If the glass had been concave only on one side, and the other side quite flat, the

rays would have diverged, after passing through it, as if they had come from a radiant point at double the distance of C from the glass; that is, as if the radiant had been at the distance of a whole diameter of the glass's convexity.

If rays come more converging to such a glass, than parallel rays diverge after passing through it, they will continue to converge after passing through it; but will not meet so soon as if no glass had been in the way; and will incline towards the same side to which they would have diverged, if they had come parallel to the glass.

Of Reflection. When a ray of light falls upon any body, it is reflected, so that the angle of incidence is equal to the angle of reflection; and this is the fundamental fact upon which all the properties of mirrors depend. This has been attempted to be proved upon the principle of the composition and resolution of forces or motion: let the motion of the incident ray be expressed by A C (fig. 2); then A D will express the parallel motion, and A B the perpendicular motion. The perpendicular motion after reflection will be equal to that before reflection, and therefore may be expressed by D C = A D. The parallel motion, not being affected by reflection, continues uniform, and will be expressed by D M = A D; therefore the course of the ray will be C M, and by a well-known proposition in Euclid A C D = D C M. The fact may, however, be proved by experiment in various ways; the following method will be readily understood.

Having described a semicircle on a smooth board, and from the circumference let fall a perpendicular bisecting the diameter, on each side of the perpendicular cut off equal parts of the circumference; draw lines from the points in which those equal parts are cut off to the centre; place three pins perpendicular to the board, one at each point of section in the circumference, and one at the centre; and place the board perpendicular to a plane mirror. Then look along one of the pins in the circumference to that in the centre, and the other pin in the circumference will appear in the same line produced with the first, which shews that the ray which comes from the second pin, is reflected from the mirror at the centre of the eye, in the same angle in which it fell on the mirror. 2. Let a ray of light, passing through a small hole into a dark room, be reflected from a plane mirror, at equal distances from the point of reflection, the incident, and the reflected ray, will be at the same height from the surface.

Again, if from a centre, C, with the radius, C A, the circle, A M P, be described, the arc, A O, will be found equal to the arc, O M, therefore the angle of incidence is equal to the angle of reflection. The same is found to hold in all cases when the rays are reflected at a curved surface, whether it be convex or concave.

With regard to plane specula, it is found that the image and the object formed by it are equally distant from the speculum, at opposite sides: they are also equal, and similarly situated.

When parallel rays, as *d f a*, C *m b*, *e l c*, (fig. 9) fall upon a concave mirror, A B, they will be reflected back from that mirror, and meet in a point, *m*, at half the distance of the surface of the mirror from C, the centre of its concavity; for they will be reflected at as great an angle from the perpendicular to the surface of the mirror, as they fell upon it, with regard to that perpendicular, but on the other side thereof. Thus, let C be the centre of the concavity of the mirror, A *b* B, and let the parallel rays, *d f a*, C *m b*, and *e l c*, fall upon it at the points, *a*, *b* and *c*. Draw the lines, C *i a*, C *m b*, and C *h c*, from the centre, C, to these points; and all these lines will be perpendicular to the surface of the mirror, because they proceed thereto like so many radii from its centre. Make the angle, C *a h*, equal to the angle *d a* C, and draw the line, *a m h*, which will be the direction of the ray, *d f a*, after it is reflected from the point of the mirror: so that the angle of incidence, *d a* C, is equal to the angle of reflection, C *a h*; the rays making equal angles with the perpendicular, C *i a*, on its opposite sides. Draw also the perpendicular, C *h c*, to the point, *c*, where the ray, *e l c*, touches the mirror; and having made the angle, C *c i*, equal to the angle, C *c e*, draw the line, *c m i*, which will be the course of the ray, *e l c*, after it is reflected from the mirror. The ray, C *m b*, passes through the centre of concavity of the mirror, and falls upon it at *b*, perpendicular to it; and is therefore reflected back from it in the same line, *b m* C. All these reflected rays meet in the point, *m*; and in that point the image of the body which emits the parallel rays, *d a*, C *b*, and *e c*, will be formed; which point is distant from the mirror equal to half the radius, *b m* C, of its concavity.

The rays which proceed from any celestial object, may be esteemed parallel at the earth; and, therefore, the images of that object will be formed at *m*, when the reflecting surface of the concave mirror is turned directly towards the object. Hence the focus of the parallel rays is not in the centre of the mirror's concavity, but half way between the mirror, and that centre. The rays which proceed from any remote terrestrial object are nearly parallel at the mirror; not strictly so, but come diverging to it in separate pencils, or, as it were, bundles of rays, from each point of the side of the object next the mirror; therefore they will not be converged to a point at the distance of half the radius of the mirror's concavity from its reflecting surface, but in separate points at a little greater distance from the mirror. And the nearer the object is to the mirror, the further these points will be from it; and an inverted image of the object will be formed in them, which will seem to hang pendent in the air; and will be seen by an eye placed beyond it (with regard to the mirror), in all respects like the object, and as distinct as the object itself.

Let A *c* B (fig. 10), be the reflecting surface of a mirror, whose centre of concavity is at C; and let the upright object, D E, be placed beyond the centre, C, and send out a conical pencil of diverging rays from its upper extremity, D, to every point of the concave surface of the mirror, A *c* B. But, to avoid confusion, we only draw three rays of that pencil; as D A, D *c*, D B. From the centre of concavity, C, draw the three right lines, C A, C *c*, C B, touching the mirror in the same points where the aforesaid touch it, and all these lines will be perpendicular to the surface of the mirror. Make the angle, C A *d* equal to the angle, D A C, and draw the right line A *d*, for the course of the reflected ray, D A: make the angle, C *c d*, equal to the angle, D *c* C, and draw the right line, *c d*, for the course of the reflected ray, D *c*; make also the angle, C B *d*, equal to the angle, D B C, and draw the right light line, B *d*, for the course of the reflected ray, D B. All these reflected rays will meet in point *d*, where they will form the extremity, *d*, of the inverted image, *e d*, similar to the extremity, D, of the upright object, D E. If the pencil of rays, E *f*, E *g*, E *h*, be also continued to the mirror, and their angles of reflection from it be made equal to their angles of incidence upon it, as in the former pencil from D, they will meet at the point, *e*, by reflection, and form the extremity, *e*, of the image, *e d*, similar to the extremity, E, of the object, D E. As each intermediate point of the object between D and E, sends out a pencil of rays in like manner to every part of the mirror, the rays of each pencil will be reflected back from it, and meet in all the intermediate points between the extremities, *e* and *d*, of the image; and so the whole image will be formed, not at *i*, half the distance of the mirror from its centre of concavity, C; but at a greater distance between *i* and the object, D E; and the image will be inverted with respect to the object. This being well understood, the reader will easily see how the image is formed by the large concave mirror of the reflecting telescope, when he comes to the description of that instrument. See TELESCOPE.

When the object is more remote from the mirror than its centre of concavity, C, the image will be less than the object, and between the object and the mirror; when the object is nearer than the centre of concavity, the image will be more remote, and bigger than the object: thus, if D E be the object, *e d* will be its image; for as the object recedes from the mirror, the image approaches nearer to it; and as the object approaches nearer to the mirror, the image recedes further from it, on account of the lesser or greater divergency of the pencils of rays which proceed from the object; for the less they diverge, the sooner they are converged to points by reflection; and the more they diverge, the further they must be reflected before they meet. If the radius of the mirror's concavity and the distance of the object of it be known, the distance of the image from the mirror is found by this rule: Divide the product of the distance and radius by double the distance made less by the radius, and the quotient is the distance required. If the object be in the centre of the mirror's concavity, the image and object will be coincident, and equal in bulk.

If a man place himself directly before a large concave mirror, but further from it than its centre of concavity, he will see an inverted image of himself in the air, between him and the mirror, of a less size than himself. And if he hold out his hand towards the mirror, the hand of the image will come out towards his hand, and coincide with it, of an equal bulk, when

his hand is in the centre of concavity; and he will imagine he may shake hands with his image. If he reach his hand further, the hand of the image will pass by his hand, and come between it and his body; and if he move his hand towards either side, the hand of the image will move towards the other; so that whatever way the object moves, the image will move the contrary way. A by-stander will see nothing of the image, because none of the reflected rays that form it enter his eyes.

The images formed by convex specula are in positions similar to those of their objects; and those also formed by concave specula, when the object is between the surface and the principal focus: in these cases the image is only imaginary, as the reflected rays never come to the foci from whence they seem to diverge. In all other cases of reflection from concave specula, the images are in positions contrary to those of their objects, and these images are real, for the rays after reflection do come to their respective foci. These things are evident from what has gone before. See Mirror.

"Of colours and the different refrangibility of light." The origin of colours is owing to the composition which takes place in the rays of light, each heterogeneous ray consisting of innumerable rays of different colours; this is evident from the separation that ensues in the well-known experiment of the prism. A ray being let into a darkened room (fig. 11) through a small round aperture, *z*, and falling on a triangular glass prism, *x*, is by the refraction of the prism considerably dilated, and will exhibit on the opposite wall an oblong image, *a b*, called a spectrum, variously coloured, the extremities of which are bounded by semicircles, and the sides are rectilinear. The colours are commonly divided into seven, which, however, have various shades, gradually intermixing at their juncture. Their order, beginning from the side of the refracting angle of the prism, is red, orange, yellow, green, blue, purple, violet. The obvious conclusion from this experiment is, that the several component parts of solar light have different degrees of refrangibility, and that each subsequent ray in the order above mentioned is more refrangible than the preceding.

As a circular image would be depicted by the solar ray unrefracted by the prism, so each ray that suffers no dilatation by the prism would mark out a circular image, *y*. Hence it appears, that the spectrum is composed of innumerable circles of different colours. The mixture, therefore, is proportionable to the number of circles mixed together (fig. 12); but all such circles are mixed together, whose centres lie between those of two contingent circles, consequently the mixture is proportionable to the interval of those centres, *i. e.* to the breadth of the spectrum. If therefore the breadth can be diminished, retaining the length of the rectilinear sides, the mixture will be lessened proportionably, and this is done by the following process.

At a considerable distance from the hole, *z*, place a double convex lens, A B (fig 13), whose focal length is equal to half that distance, and place the prism *x*, behind the lens; at a distance behind the lens, equal to the distance of the lens from the hole, will be formed a spectrum, the length of whose rectilinear sides is the same as before, but its breadth much less; for the undiminished breadth was equal to a line subtending, at the distance of the spectrum from the hole, an angle equal to the apparent diamater of the sun, together with a line equal to the diameter of the hole; but the reduced breadth is equal to the diameter of the hole only; the image of the hole formed by the lens at the distance of double its focal length, is equal to the hole; therefore, its several images in the different kinds of rays are equal to the same, *i. e.* the breadth of the reduced spectrum is equal to the diameter of the hole.

A prism A B C, (fig. 14, Plate II.) placed in an horizontal position, would project the ray into an oblong form, as has been seen; apply another horizontal prism, A D B, similar to the former, to receive the refracted light emerging from the first, and having its refracting angle turned the contrary way from that of the former. The light, after passing through both prisms, will assume a circular form, as if it had not been at all refracted.

If the light emerging from the first prism be received by a second, whose axis is perpendicular to that of the former, it will be refracted by this transverse prism into a position inclined to the former, the red extremity being least, and the violet most removed from its former position; but it will not be at all altered in breadth.

Close to the prism A (fig. 15), place a perforated board, *a b*, and let the refracted light (having passed through the small hole) be received on a second board, *c d*, parallel to the first, and perforated in like

manner; behind that hole in the second board place a prism, with its refracting angle downward, turn the first prism slowly about its axis, and the light will move up and down the second board; let the colours be transmitted successively, and mark the places of the different coloured rays on the wall after their refraction by the second prism, the red will appear lowest, the violet highest, the rest in the intermediate places in order. Here then the light being very much simplified, and the incidences of all the rays on the second prism exactly the same; the red was least refracted, the violet most, &c.

The permanency of these original colours appears from hence, that they suffer no manner of change by any number of refractions, as is evident from the last mentioned experiment; nor yet by reflection; for if any coloured body be placed in simplified homogeneous light, it will always appear of the same colour of the light in which it is placed, whether that differ from the colour of the body or not; *e. g.* if ultra marine and vermilion be placed in a red light, both will appear red; in a green light, green; in a blue light, blue, &c. It is, however, to be allowed, that a body appears brighter when in a light of its own colour than in another; and from this we see that the colours of natural bodies arise from an aptitude in them to reflect some rays more copiously and strongly than others; but lest this phenomenon should produce a doubt of the constancy of the primary colours, it is proper to assign the reason of it, which is this: that when placed in its own coloured light, the body reflects the rays of the predominant colour more strongly than any of those intermixed with it; therefore the proportion of the rays of the predominant colour to those of the others, in the reflected light, will be greater than in the incident light; but when the body is placed in a light of a different colour from its own, for a similar reason the contrary effect will follow, *i. e.* the proportion of the predominant colour to the others will be less in the reflected than in the incident light, and therefore as its splendour would be greater in the former case, and would be less in the latter than if all the rays were equally reflected, the splendour of the predominant colour will be much greater in the former case than in the latter.

As a solar ray was separated into several others of different colours, so, on the contrary, from these homogeneous rays a ray of heterogeneous light may be compounded, perfectly corresponding both in appearance and properties with the solar rays.

The coloured rays (fig. 16) diverging from the prism are received by a double convex lens, at the distance of twice its focal length from the hole; at the same distance behind the lens, where they are collected by its refraction, they are received on a second prism, whose refracting angle is equal to that of the former; the divergence of the homogeneous rays that would otherwise ensue, is counteracted by the second prism, and they are made to proceed parallel to each other from the place of their intersection, and therefore are all compounded and mixed together in the emergent ray A B, which is exactly of the same appearance with the solar rays, and by experiments made on it similar to those usually made in solar light, is found to possess the same properties.

Since then, 1. A solar ray may be resolved into several differently coloured rays; 2. Since their colours are immutable either by reflection or refraction, and therefore probably not generated in those operations; and 3. Since from the mixture of those coloured rays solar light may be formed, it seems an indisputable conclusion that the differently coloured rays do exist in solar light previously to any separation that takes place in experiments.

White is compounded of all the primary colours, mixed in their due proportions, for if a solar ray be separated by the prism into its component parts, and at a proper distance a lens be so placed as to collect the diverging coloured rays again into a focus, a paper placed perpendicularly to the rays in this point will exhibit whiteness.

The same conclusion may be drawn from the experiment of mixing together paints of the same colours as the parts of the spectrum, and in the same proportion; the mixture will be white, though not of a resplendent whiteness, because the colours mixed are less bright than the primary ones; this may likewise be proved, by fixing pieces of cloth of all the different colours on the rim of a wheel, and whirling it round with great velocity, it will appear to be white. Though seven different colours are distinguishable in the prismatic spectrum, yet, upon examining the matter with more accuracy, we shall see that there are, in fact, only

three original colours, red, blue, and yellow: for the orange being situated between the red and yellow, is only the mixture of these two: the green, in like manner, arises from the blue and yellow; and the violet from the blue and red.

As the colour of a body, therefore, proceeds from a certain combination of the primary rays which it reflects; the combination of rays flowing from any point of an object will, when collected by a glass, exhibit the same compound colour in the corresponding point of the image. Hence appears the reason why the images formed by glasses have the colours of the objects which they represent.

The instance of the separation of the primary colours of light which seems most remarkable, is that of the Rainbow. It is formed, in general, by the reflection of the rays of the sun's light from the drops of falling rain, though frequently it appears among the waves of the sea, whose heads, or tops, are blown by the wind into small drops, and it is sometimes seen on the ground, when the sun shines on a very thick dew. Cascades and fountains, whose waters are in their fall divided into drops, exhibit rainbows to a spectator, if properly situated during the time of the sun's shining; and water blown violently from the mouth of an observer, whose back is turned towards the sun, will, with care, produce the same phenomenon. See Rainbow.

This appearance is also seen by moonlight, though seldom vivid enough to render the colours distinguishable; and the artificial rainbow may be produced even by candle-light, on the water which is ejected by a small fountain, or *jet d'eau*. All these are of the same nature, and dependent on the same causes, *viz.* the various refrangibility of the rays of light.

The colours observable on soap-bubbles, and the halos which sometimes surround the moon, are also referable to the same origin.

"Of the Eye, and the nature of Vision." The eye is nearly of a spherical shape, and is composed of three different substances, called, 1. The aqueous, P. (fig. 17). 2. The crystaline, R; and 3. The vitreous humours, V, enclosed by three principal coats, which are formed by the expansion of the different component parts of the optic nerve, *viz.* the sclerotica, S. S. 2. The choroides, D D; and 3. The retina, T T. The sclerotica is outermost; it is very strong, and the forepart, which is transparent, and somewhat prominent, is called the cornea, C. The choroides is next in order, and has a circular perforation, P, called the pupil, immediately behind the middle of the cornea: the part II. of the choroides, visible behind the cornea, is flat; it is called the iris, or uvea, and is differently coloured in different persons. The retina is the inmost coat, it extends round the eye till it meets the ciliary ligaments, Q Q, membranes proceeding from the choroides, and attached to the capsula or filament, which encloses the crystaline humours, R. The crystaline is the most dense of the three humours, and is in the shape of a double convex lens, whose forepart has the less curvature; the cavity between the cornea and the crystaline is occupied by the aqueous humour, which has rather the least density of the three, and the space between the bottom of the eye and the crystaline is filled by the vitreous humour, V.

Objects presented to the eye have their images painted on the back part of the retina, the rays of the incident pencils converging to their proper foci there by the refraction of the different humours; and for this office they are admirably adapted; for as the distance between the back and front of the eye is very small, and the rays of each of the pencils that form the image fall parallel, or else diverging on the eye, a strong refractive power is necessary for bringing them to their foci at the retina; but each of the humours, by its peculiar form and density, contributes to cause a convergence of the rays; the aqueous from its convex form; the crystaline by its double convexity and greater density than the aqueous; and the vitreous by a less density than the crystaline joined to its concave form.

These things are manifest from what has been already said. The structure of the eye is in general adapted to the reception of parallel rays; but as the distances of visible objects are various, so the eye has powers of accommodating itself to rays proceeding from different distances, by altering the distance of the crystaline from the retina, which is done by the action of the ciliary ligaments.

That this change of situation in the crystaline is adequate to such accommodation, may be thus shewn. Suppose a pencil of rays to diverge from a point, A, (fig. 18.) at a distance from the eye less than that which admits distinct vision in the usual situation of the humours: the rays would come to a focus, V, behind

the retina, L M. Let the crystaline, O P, be brought forward, and, C V, the distance of the focus from the crystaline, will be increased; but, because of the great proportion that A C, the smallest distance that admits distinct vision has to F C, the focal length of the crystaline, the distance, C G, of the crystaline from the retina will be more increased than C V, so that C G and C V may become equal, and thus the focus made to fall exactly on the retina.

These powers of accommodation are however limited, and the sight is said to be perfect, when the eye can adapt itself to any distance within the usual limits, and when it cannot, vision is indistinct.

Defective sight arises from an incapacity of altering the position of the crystaline within the usual limits. 1. When it cannot be brought close enough to the cornea, near objects appear indistinct; to this defect people in years are generally subject. 2. Where the crystaline cannot be drawn sufficiently near to the retina, remote objects appear indistinct; this is the defect under which myopes, or short-sighted people, labour. In each of these cases, the images of the different points in the object would be diffused over small circles on the retina; and so being intermixed and confounded with each other, would there form a very confused picture of the object: for in the former case (fig. 19), the image of any point would be formed behind the retina, as the refraction of the eye is not sufficiently strong to bring the rays (diverging so much as they do in proceeding from a near point) to a focus at the retina. This defect will therefore be remedied by a convex glass, *a b*, which makes the point whence the rays now proceed more distant than the object; therefore the rays falling on the eye will now diverge less than before, or else be parallel, and will of course be brought to a nearer focus, *viz.* at the retina.

In the latter case the image is formed before the retina (fig. 20) because the refractive power of the eye is too great to permit rays so little diverging (as they do in proceeding from a distant point) to reach the retina before they are collected into a focus; in this case the defect is supplied by a concave glass, *a b*, which makes the point whence the rays diverge, nearer than the object; consequently, the rays falling on the eye will now diverge more than before, so as when refracted through the humours not to come to their focus before they reach the retina.

Spectacles are constructed on the above principles, concave for short-sighted, and convex for long-sighted people. See SPECTACLES and VISION.

"Of microscopes and other optical instruments." The impediments to the vision of very near objects arise from too great a divergence of the rays in each pencil incident on the eye, and are remedied by the microscope. This instrument is of two kinds: 1. refracting; and, 2. reflecting.

The refracting microscope is either single or compound. The former is a small double convex lens, of a short focal length; the object is placed in its focus, by which disposition the rays of each pencil emerging from the lens become parallel, and so are brought to their respective foci on the retina by the humours of the eye: the magnifying power of the instrument appears from hence.

The apparent lineal magnitude of an object seen with this instrument, is to its lineal magnitude seen with the naked eye, as the least distance that admits of distinct vision with the naked eye, to the focal length of the lens; for these magnitudes are as the angles under which the object appears, *i. e.* inversely as the distances at which it is viewed.

A compound microscope is composed of two double convex glasses, the broader next the eye. In this instrument the distance of the object from the object-glass is to be made greater than the focal length of that lens; then the image will be formed at the focus conjugate to the place of the object, and the eye-glass being placed at its own focal distance from the image, will make the rays emerge parallel to each other, and consequently produce distinct vision. See MICROSCOPE.

To enlarge the field of the compound microscope, it is usual to insert a broad lens, as in the astronomical telescope, between the object-glass and the image.

The reflecting microscope is thus constructed: In the extremity of a broad tube insert a concave speculum N U (fig. 21); a point O in its axis, whose distance from the vertex, V, is greater than the focal length of the concave, is the place for the object, whose image will consequently be formed at the focus, G, conjugate to the point O: at the distance of its own focal length, L G, place a double convex lens, *a b*, by which the image will

be seen distinctly. The object is illuminated by light admitted into the tube through a space, P R, adjoining to the speculum; and the illustration of the object may be rendered more intense by a concave speculum, A B, which shall reflect the light so admitted to a focus at the place of the object.

A solar microscope is constructed in the following manner: In the inside of a tube is placed a convex lens, A B (fig. 22); and at a distance a little greater than its focal length, but less than double of it, is fixed some transparent coloured object, Q P, whose image will be painted much enlarged at the focus conjugate to the place of the object. A broad lens C D, is placed before the object to collect the solar rays, for the purpose of illuminating it more strongly, and consequently making the image more distinct and vivid. On the same principle is constructed the Magic Lantern, which see.

The camera obscura is an instrument used to facilitate the delineation of prospects. It is constructed in the following manner: A C (fig. 23), represents a box of about a foot and a half square, shut on every side, except D C; O P is a smaller box placed on the top of the greater; M N is a double convex lens, whose axis makes an angle of 45° with B L, a plane mirror fixed in the box O P; the focal length of the lens is nearly equal to C S + S T, *i. e.* to the sum of the distances of the lens from the middle of the mirror, and of the middle of the mirror from the bottom of the larger box. The lens being turned toward the prospect would form a picture of it, nearly at its focus; but the rays being intercepted by the mirror will form the picture as far before the surface as the focus is behind it, *i. e.* at the bottom of the larger box, a communication being made between the boxes by the vacant space Q O. The draughtsman then putting his head and hands into the box through the open side, D C, and drawing a curtain round to prevent the admission of the light, which would disturb the operation, may trace a distinct outline of the picture that appears on the bottom of the box.

There is another kind of camera obscura, constructed thus. In the extremity of the arm, P Q (fig. 24), that extends from the side of a small square box, B L, is placed a double convex lens, whose axis is inclined in an angle of 45° to a plane mirror B O: the focal length of the lens is equal to its distance from the side of the box O T; therefore, when the lens is turned towards the illuminated prospect, it would project the image on the side O T, if the mirror were removed, but this will reflect the image to the side M L, which is as far distant from the middle of the mirror, as this is from the side O T; it is there received on a piece of glass, rough at the upper side and smooth at the lower, and appears in its proper colours on the upper side of the plate. It is evident that in each of these instruments the image is inverted with respect to the object.

M S is a lid to prevent the admission of light during the delineation of the picture, and others for the same purpose are applied to the sides M R and N L.

Dr. Wollaston has recently invented a portable instrument for drawing in perspective, to which he has given the name of Camera Lucida. In this instrument two plane reflectors are fixed at such angles with regard to each other, that the objects intended to be delineated are seen after reflection from the second mirror, as though they were on the same plane as that whereon the paper is placed which is to contain the drawing. These plane reflectors may be either common mirrors with a silver coating at the back of each, or two contiguous faces of a glass prism, in which latter case the image will be produced by what is called prismatic reflection. In either case the most convenient position, in which the reflecting surfaces can be arranged, will be such as will cause the rays proceeding directly from the object and falling as incident rays upon the first surface, after reflection from thence to the second, to emerge from that second reflecting surface in angles of 90 degrees, with the direction of the original incident rays; for in these circumstances vertical objects may be projected upon a horizontal plane, and the instrument will be adapted to drawing upon a horizontal surface. Now, if two plane mirrors are used, the incident rays upon the first will make right angles with the emergent rays from the second, when those mirrors are fixed so as to make angles of either 45 or 135 degrees with each other. In this case the mirror which first receives the rays from the object may be entirely silvered at its back; but the second mirror is only to have a sufficient portion silvered to reflect the image of the proposed object to the eye; and thus to allow the paper, on which the drawing is to be made, to be seen either through an opening of the

silvering or past the edges of the same, by one portion of the eye, while the double reflected object is seen in the silvering by the other portion of the same eye. When prismatic reflection is employed, the prism must not be triangular as usually constructed, but quadrangular, and the two reflecting surfaces (to produce an angle of 90 degrees between the first incident and second emergent rays) must make an angle of 135 degrees, while the opposite angle must be one of 90 degrees, and the other two angles may be either respectively equal or unequal at pleasure; then one of the faces which make right angles with each other is to be turned towards the object or objects to be delineated, and the rays after passing through that surface and reflection from the two next faces, will emerge from the fourth under the proposed angle. The mirrors or other reflecting surfaces are mounted in a proper frame, and supported at a suitable distance from the paper intended to receive the drawing; and, when necessary, either a double concave or a double convex glass may be fixed in the frame, and properly adjusted to produce distinct vision when the apparatus is used by short-sighted or long-sighted persons respectively. These concave or convex glasses may conveniently be made of twelve inches focal length; the instrument must then be supported at the distance of twelve inches from the paper; a distance which is convenient enough in other respects.

Dr. Wollaston has himself published a description of this instrument, in Nicholson's Philosophical Journal, where he likewise institutes a comparison between the Camera Obscura and the Camera Lucida. The objections to the Camera Obscura are, 1. That it is too large to be carried about with convenience. The Camera Lucida is as small and portable as can be wished. 2. In the former, all objects that are not situated near the centre of view are more or less distorted. In this, there is no distortion; so that every line, even the most remote from the centre of view, is as straight as those through the centre. 3. In that, the field of view does not extend beyond 30°, or at most 35°, with distinctness. But in the Camera Lucida as much as 70° or 80° might be included in one view.

Dr. Wollaston remarks further, that by a proper use of the same instrument every purpose of the pentagraph may also be answered; as a painting may be reduced in any proportion required, by placing it at a distance in due proportion greater than that of the paper from the instrument, In this case a lens becomes requisite for enabling the eye to see at two unequal distances with equal distinctness; and in order that one lens may suit for all these purposes, there is an advantage in varying the height of the stand according to the proportion in which the reduction is to be effected.

OPTION, in law, every bishop, whether created or translated, is bound immediately after confirmation, to make a legal conveyance to the archbishop, of the next avoidance of such dignity or benefice belonging to the see, as the said archbishop shall choose, which is therefore called an option.

OR, in heraldry, denotes yellow, or gold colour. In the coats of noblemen it is blazoned topaz; and in those of sovereign princes, sol. It is represented in engraving by small points or dots, scattered all over the field or bearing.

ORATORIO, in music, a species of musical drama, originally an imitation of the serious opera, the subject of which is generally taken from scripture, and can be only treated properly by music of the sublimest style.

ORBIT, in astronomy, the path of a planet or comet, or the curve that it describes in its revolution round its central body: thus the Earth's orbit is the curve which it describes in its annual course, and usually called the ecliptic The orbits of all the planets are ellipses having the Sun in their common focus; in which curve they move according to an invariable law. See Astronomy. However, the orbit of the Earth is considerably disfigured by the action of the Moon; as is also the orbit of Saturn by the action of Jupiter, when they happen to be in conjunction. Though the orbits of the planets be elliptical, not circular, yet that they are very little so, even in the most eccentric orbit, as that of Mercury, will appear, by comparing their eccentricities with their mean distances from the Sun. The orbits of the planets are not all in the same plane with the ecliptic, but are variously inclined to it, and to each other; but still the plane of the ecliptic intersects the plane of the orbit of every other planet in a right line, which passes through the Sun, called the line of the nodes, and the points of intersection of the orbits themselves are called the nodes.

ORCHESTRA, in music, that enclosed part of the theatre between the audience

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and the curtain; in which the instrumental performers sit.

ORCHIDEÆ, in botany, the seventh order in Linnæus's Fragments of a Natural Method, consisting of Orchis, and the plants that resemble it in habit, powers, and sensible qualities. The flowers are hermaphrodite, and placed at the summit of the stalk, either in a spike, or in a panicle. Each flower is accompanied with a leaf that is smaller than the other leaves, and forms a sort of sheath round the stalk. The petals are five in number, and very irregular. The flowers of the different species are remarkably various and singular in their shape, resembling different kinds of animals or insects.

ORCHIS, in botany, a genus of the Gynandria Diandria class and order. Natural order of Orchideæ. Essential character: nectary a horn or spur behind the flower. There are fifty species. Among which we shall notice the O. bifolia, butterfly orchis. This plant has ovate bulbs, tapering to a point at the base; thick fleshy fibres proceed above them from the base of the stem; one of these bulbs is always wrinkled and withered, whilst the other is plump and delicate; the first is the parent of the actual stem; the second is an offset, from the centre of which the stem of the succeeding year is destined to arise. Such are the means that nature uses, not only to disseminate plants, but to enable them to change their place, and thus to draw in fresh nutriment. The second root is always about half an inch from the centre of the first, so that in twenty years the plant will have marched ten inches from the place of its birth. This mode of increase is particularly necessary in a family of plants that rises with great difficulty, and very seldom by seed. O. conopsea, long-spurred Orchis, is distinguished by the remoteness of the cells or cases in which the stamens are lodged, and again by the colour of the corolla, the great length of the spur, the delicious fragrance of its flowers, vying with that of the honeysuckle, and particularly by the unusual structure of its flowers. Below the stigma, which is remarkably well defined in this species, there is a circular opening between the cavities containing the stamens; just above the stigma is a very conspicuous ridge; the stamens soon change to a brownish hue; the anthers are club shaped, and are divided as in most others, the gland at the base of the filament is of a circular form, with a cavity on its inner side: the roots of this species are well calculated for making salep.

ORDEAL, was anciently a form of trial, and was of two sorts; either fire ordeal, or water ordeal; the former being confined to persons of higher rank, the latter to the common people. Both these might be performed by deputy, but the principal was to answer for the success of the trial; the deputy only venturing some corporeal pain for hire, or perhaps for friendship. Fire ordeal was performed either by taking up in the hand a piece of red hot iron, of one, two, or three pounds weight; or else by walking barefoot and blindfold over nine red hot ploughshares, laid at unequal distances; and if the party escaped unhurt, he was adjudged innocent; if not, he was condemned as guilty. Water ordeal was performed, either by plunging the bare arm up to the elbow in boiling water, and escaping unhurt thereby, or by casting the person suspected into a river or pond of water: and if he floated, without any action of swimming, it was deemed an evidence of his guilt; but if he sunk he was acquitted. This trial by ordeal was abolished by parliament anno 3 Henry III.

ORDER, in architecture, is a system of the several members, ornaments and proportions of columns and pilasters; or a regular arrangement of the projecting parts of a building, especially the column, so as to form one beautiful whole. There are five orders of columns, of which three are Greek, *viz.* the Doric, Ionic, and Corinthian, and two Roman, the Tuscan and Composite. The three Greek orders represent the three different manners of building, *viz.* the solid, the delicate, and that which is between the two. See ARCHITECTURE.

ORDER, in astronomy. A planet is said to go according to the order of the signs when it is direct, proceeding from Aries to Taurus, thence to Gemini, &c. It goes contrary to the order of the signs when it is retrograde, or goes backward from Pisces to Aquarius.

ORDER, in geometry, is denominated from the rank or order of the equation by which the geometrical line is expressed: thus the simple equation, or first power, denotes the first order of lines, which is a right line: the quadratic equation, or second power, defines the second order of lines, which are the conic sections and circle: the cubic equation, or third power, defines the third order of lines; and so on. Or the orders of lines are denominated from the number of points in which they may be cut by a right line. Thus the right line is of the first order, because it can be cut only in one point by a right

line: the circle and conic sections are of the second order, because they can be cut in two points by a right line; while those of the third order are such as can be cut in three points by a right line.

Order, in botany, the first subdivision of a class in the Linnæan system, founded on the number of styles or female organs. The orders of Linnæus are all expressed by a single term, which like the names of the classes, is of Greek etymology, and is significant of the character of the order to which it is applied. The names of these orders are often different in different classes, because the same idea predominates in their institution.

ORDINANCE, or *Ordonnance*, a law, statute, or command of a sovereign or superior.

ORDINARY, in the civil law, signifies any judge that hath authority to take cognizance of causes in his own right, as he is a magistrate, and not by deputation; but in the common law it is taken for him who has exempt and immediate jurisdiction in causes ecclesiastical.

Ordinary, or *honourable Ordinary*, in heraldry, a denomination given to certain charges properly belonging to that art. The honourable ordinaries are ten in number; *viz.* the chief, pale, bend, sesse, bar, cross, saltier, chevron, bordure, and orle. For which see Heraldry, &c.

ORDINATES, in geometry, are right lines drawn parallel to each other, and cutting the curve in a certain number of points. Parallel ordinates are usually all cut by some other line, which is called an absciss. When this line is a diameter of the curve, the property of the ordinates is then the most remarkable; for, in the curves of the first kind, or the conic sections and circle, the ordinates are all bisected by the diameter, making the part on one side of it equal to the part on the other side of it; and in the curves of the second order, which may be cut in three points by an ordinate, then of the three parts of the ordinate, lying between these three intersections of the curve and the intersection with the diameter, the part on one side the diameter is equal to both the two parts on the other side of it. And so for curves of any order, whatever the number of intersections may be, the sum of the parts of any ordinate, on one side of the diameter, is equal to the sum of the parts on the other side of it. The use of ordinates in a curve, and their abscisses, is to define or express the nature of a curve by means of the general relation or equation between them; and the greatest number of factors, or the dimensions of the highest term, in such equation, is always the same as the order of the line; that equation being a quadratic, or its highest term of two dimensions, in the lines of the second order, being the circle and conic sections; and a cubic equation, or its highest term containing three dimensions, in the lines of the third order, and so on. Thus, y denoting an ordinate and x its absciss, also $a\ b\ c$, &c. given quantities: then $y^2 = a x^2 + b x + c$ is the general equation for the lines of the second order: and $x y^2 - e y = a x^3 + b x^2 + c x + d$ is the equation for the lines of the third order, and so on.

ORDINATION, the act of conferring holy orders, or of initiating a person into the priesthood by prayer, and the laying on of hands. Ordination has always been esteemed the principal prerogative of bishops, and they still retain the function as a mark of spiritual sovereignty in their diocese. Without ordination, no person can receive any benefice, parsonage, vicarage, &c. A clerk must be twenty-three years of age before he can have any share in the ministry; and twenty-four before he can be ordained, and by that means be permitted to administer the sacraments. A bishop, on the ordination of clergymen, is to examine them in the presence of the ministers who assist him at the imposition of hands: and in case any crime, as drunkenness, perjury, forgery, &c. be alleged against any one that is to be ordained, either priest or deacon, the bishop ought to desist from ordaining him. The person to be ordained is to bring a testimonial of his life and doctrine to the bishop, and give an account of his faith in Latin, and both priests and deacons are obliged to subscribe the thirty-nine articles.

ORDNANCE, a general name for all sorts of great guns used in war.

Ordnance, *office of*, an office kept within the Tower of London, which superintends and disposes of all the arms, instruments, and utensils of war, both by sea and land, in all the magazines, garrisons, and forts, in Great Britain.

The officers of the ordnance are: 1. The Master General, from whom are derived all orders and despatches relating to the same. 2. The Lieutenant General, who receives orders from the Master General, and sees them duly executed; orders the firing of guns on days of rejoicing, and sees the train of artillery fit-

ted out when ordered to the field. 3. The Surveyor General, who has the inspection of the ordnance, stores, and provisions of war in the custody of the store-keepers: he allows all bills of debt, keeps a check on labourers, &c. 4. The Treasurer, through whose hands passes the money of the whole office, as well for payment of salaries as debentures; as also a Clerk of the Ordnance, and a Clerk of the Deliveries, for which see the articles, CLERK *of the ordnance*, &c.

ORES, in mineralogy. An ore is a metal in the state in which it exists in the earth. It may be either native, that is pure, and uncombined with any other substance, or alloyed with another metal; or in a state of an oxide, or a sulphuret, or a carburet, or of a metallic salt. It is also mixed in most instances with various earthy minerals. The ores of metals may be analyzed in two modes, in the humid and the dry way. The first is effected with the aid of acids, and of other liquid agents, and may often be accomplished by very simple means, and without the aid of a bulky and expensive apparatus. If sulphur be present, it impedes the action of acids, and should be separated by roasting the ore on a muffle, or by projecting it mixed with twice its weight of nitre into a red-hot crucible, washing off the alkali afterwards with hot water. No solvent will act upon all the metals. Thus nitric acid does not act on gold and platina; and the nitro-muriatic acid, which dissolves these metals, has no solvent action on silver. Hence the necessity of varying the solvent according to the nature of the ore under examination. We shall give a few instances, by which the reader will understand the theory, and may be enabled to verify the facts by practice.

For "ores of gold and platina," the nitro-muriatic acid is the most proper solvent. A given weight of the ore may be digested with this acid, as long as it extracts any thing. The solution is to be evaporated to dryness, in order to expel the excess of acid, and dissolved in water. The addition of a solution of tin and muriatic acid will shew the presence of gold by a purple precipitate; and platina will be indicated by a precipitate, on adding a solution of muriate of ammonia. When gold and platina are both contained in the same solution, they may be separated from each other by the last mentioned solution, which throws down the platina, but not the gold. In this way platina may be detached also from other metals.

For extracting "silver" from its ores, the nitric acid is the most proper solvent. The silver may be precipitated from nitric acid by muriate of soda. Every hundred part of the precipitate contains seventy-five of silver. But, as lead may be present in the solution, and this metal is also precipitated by muriate of soda, it may be proper to immerse in the solution a polished plate of copper. This will precipitate the silver, if present, in a metallic form. The muriate of silver is also soluble in liquid ammonia, which that of lead is not.

"Copper ores" may be analyzed by boiling them with five times their weight of concentrated sulphuric acid, till a dry mass is obtained, from which water will extract the sulphate of copper. This salt is to be decomposed by a polished plate of iron, immersed in a dilute solution of it. The copper will be precipitated in a metallic state, and may be scraped off and weighed. If silver be suspected with copper, nitrous acid must be employed as the solvent; and a plate of polished copper will detect the silver.

"Iron ores" may be dissolved in dilute muriatic acid, or, if the metal be too highly oxydized to be dissolved by this acid, they must be previously mixed with one-eighth of their weight of powdered charcoal, and calcined in a crucible for an hour. The iron is thus rendered soluble. The solution must then be diluted with ten or twelve times its quantity of water, previously well boiled, to expel the air, and must be preserved in a well-stopped glass bottle for six or eight days. The phosphate of iron will within that time be precipitated, if any be present, and the liquor must be decanted off. The solution may contain the oxides of iron, manganese, and zinc. It may be precipitated by carbonate of soda, which will separate them all. The oxide of zinc will be taken up by a solution of pure ammonia; distilled vinegar will take up the manganese, and will leave the oxide of iron. From the weight of this, after ignition, during a quarter of an hour, twenty-eight per cent. may be deducted.

"Tin ores." Boil 100 grains, in a silver vessel, with a solution of 600 grains of pure potash. Evaporate to dryness, and then ignite moderately for half an hour. Add boiling water, and if any portion remain undissolved, let it undergo

a similar treatment. Saturate the alkaline solution with muriatic acid, which will throw down an oxide of tin. Let this be redissolved by an excess of muriatic acid: again precipitated by carbonate of soda; and being dried and weighed, let it, after lixiviation, be once more dissolved in muriatic acid. The insoluble part consists of silix. Into the colourless solution, diluted with two or three parts of water, put a stick of zinc, round which the reduced tin will collect. Scrape off the deposit, wash, dry, and fuse it under a cover of tallow in a capsule placed on charcoal. A button of pure metallic tin will remain at the bottom, the weight of which, deducted from that of the ore, indicates the proportion of oxygen. The presence of tin in an ore is indicated by a purple precipitate, on mixing its solution in muriatic acid with one of gold in nitro-muriatic acid.

"Lead ores" may be analyzed by solution in nitric acid, diluted with an equal weight of water. The sulphur, if any, will remain undissolved. Let the solution be precipitated by carbonate of soda. If any silver be present, it will be taken up by pure liquid ammonia. Wash off the excess of ammonia by distilled water; and add concentrated sulphuric acid, applying heat, so that the muriatic acid may be wholly expelled.

"Mercury" may be detected in ores that are supposed to contain it, by distillation in an earthen retort with half their weight of iron filings or lime. The mercury, if any be present, will rise and be condensed in the receiver.

"Ores of zinc" may be digested with the nitric acid, and the part that is dissolved boiled to dryness, again dissolved in the acid, and again evaporated. By this means the iron, if any be present, will be rendered insoluble in dilute nitric acid, which will take up the oxide of zinc. To this solution add pure liquid ammonia, in excess, which will separate the lead and iron, if any should have been dissolved; and the excess of alkali will retain the oxide of zinc. This may be separated by the addition of an acid.

"Antimonial ores." Dissolve a given weight in three or four parts of muriatic, and one of nitric acid. This will take up the antimony, and leave the sulphur, if any. On dilution with water the oxide of antimony is precipitated, and the iron and mercury remain dissolved. Lead may be detected by sulphuric acid.

"Ores of cobalt" may be dissolved in nitro-muriatic acid. Then add carbonate of potash, which, at first, separates iron and arsenic. Filter, and add a further quantity of the carbonate, when a greyish red precipitate will fall down, which is oxide of cobalt. The iron and arsenic may be separated by heat, which volatilizes the arsenic. Cobalt is also ascertained, if the solution of an ore in muriatic acid give a sympathetic ink. See Klaproth's Essays.

To analyze ores in the dry way, a method which affords the most satisfactory evidence of their composition, and should always precede the working of large and extensive strata, a more complicated apparatus is required. An assaying furnace, with muffles, crucibles, &c. are absolutely necessary. See ASSAYING, LABORATORY, &c.

The reduction of an ore requires frequently previous roasting, to expel the sulphur and other volatile ingredients; or this may be effected by mixing the powdered ore with nitre, and projecting the mixture into a crucible. The sulphate of potash, thus formed, may be washed off, and the oxide must be reserved for subsequent experiments. As many of the metals retain their oxygen so forcibly, that the application of heat is incapable of expelling it, the addition of inflammable matter becomes expedient. And, to enable the reduced particles of metal to agglutinate and form a collected mass, instead of scattered grains, which would otherwise happen, some fusible ingredient must be added, through which, when in fusion, the reduced metal may descend, and be collected at the bottom of the crucible. Substances that answer both these purposes are called fluxes. The alkaline and earthy part of fluxes serve also another end, *viz.* that of combining with any acid which may be attached to a metal, and which would prevent its reduction, if not separated. The ores of different metals, and different ores of the same metal, require different fluxes. See FLUX. The ore, after being roasted, if necessary, is to be well mixed with three or four times its weight of the flux, and put into a crucible, with a little powdered charcoal over the surface. A cover must be luted on, and the crucible exposed to the necessary heat in a wind-furnace. Ores of iron, as being difficultly reduced, require a very intense fire. Those of silver and lead are metallized by a lower heat. The metal is found at the bottom of the crucible, in the form of a round button. The volatile metals, as mercury, zinc, arsenic, tellurium, and osmium, it is obvious, ought

not to be treated in the above manner, and require to be distilled with inflammable matters in an earthen retort. See Kirwan's Mineralogy.

ORGAN. Having, under the article Musical *instruments*, given a pretty full account of this instrument, we shall here only give a description, with figures, of the barrel-organ. See Plate I. Barrel Organ, and Plate II. parts of ditto.

The barrel-organ is generally portable, and is so contrived, that the same action of the hand, which turns the barrel, supplies the wind, by giving motion to the bellows: it consists of three principal parts: 1. The pipes, by which the sound is produced. 2. The bellows, supplying them with air. 3. The barrel and keys, by which the pipes are sounded at proper intervals. The pipes are of two kinds, of metal and of wood: the wooden ones are a square trunk of deal wood, A B, (fig. 5) closed at one end by a plug of wood, D, and at the other by a piece of wood, E, containing a crooked passage to bring air to the pipe, through the short tube, F; *a* is a piece of oak board, glued to the block E, and hollowed out to communicate with the crooked passage in it, and leaving a small crack, between it and the edge of the block, E, through which the air issues in one continued stream; in its passage it is divided by the edge of one side of the trunk, A, which is cut as sharp as possible for that purpose, and which is exactly in the same line with the orifice whence the air is emitted.

The sound is produced by the vibration of the air which is contained in the trunk, A, and by increasing or diminishing the length of the pipe, the tone is altered at pleasure, to bring it to the proper note it is to perform when placed in the instrument: this is done by sliding the plug, D, up or down in the pipe.

A metal pipe, a section of which is shown in fig. 6, is nearly the same in its operation, though different in its construction. It is a cylindric tube, of a mixture of lead and tin; A B, (fig. 6) open at one end, and nearly closed at the other by a lump of the same metal, E, which is circular for about two-thirds round, and fits the end of the pipe; the other third is a straight edge: the upper edge of the conical pipe, F, is bent to be parallel to this, and thus forms a small cleft similar to the wooden one, for the passage of the air, the lower edge of the cylindrical pipe, A B, is bent into the line of the cleft and cut sharp, to divide the current of air; these pipes are open at top, and are brought to tune by bending the pipe at the top, and thus altering its bulk: *a* is a piece of metal, called the ear, soldered upon the pipe at each end of the cleft, to prevent the stream of air being dispersed before it meets the sharp edge of the pipe, B A; in the small pipes this is not applied.

The bellows of the organ are double, as shewn in fig. 1, Plate I; that is, they are two distinct pairs, E, F, connected together at their hinge; so that when one is opening, and filling with air, the other is forcing its air out into the regulator, D; the bellows receive their motion by a rod, *d*, from a crank, *a*, on a spindle which comes through the box, in which the machine is enclosed, and has a handle on it by which it is turned. The regulator, D, is exactly similar to another pair of bellows, and is filled with air from the bellows, E F, below it, through two valves in the bottom board over the bellows; from this regulator the air proceeds through the passage, *b e f*, (seen better in the section), fig. 2, &c.

Fig. 2, Plate I, to a long trunk, *g*, going under the pipes called the air-chest, which communicates with them by a small valve, *h*, under each, it is kept shut by a small wire spring, and is opened by a wire fixed to the end of a rod, G; above the valve, the passage enlarges, and goes under two small wooden sliders or stops, *n m*, and from thence in two distinct passages to the wooden and metal pipes, N M.

The air-chest, *g*, is common to all the pipes, and each pair (of wooden and metal pipes) has a valve, *h*, and spring to themselves; the small passage above each valve belongs to each pair of pipes, and has no connection with the other; the two stops belong to all the pipes; *m*, to the metal, and *n*, to the wooden ones; they are long slips of wood drilled with so many holes as there are pipes, and at the same intervals, (the disposition of the pipes is shown in fig. 3, which is a plan of the whole instrument put together); so that when the holes are over the passages, the air has free communication from the valve to the pipes; but when the stops are drawn out, the interval between each hole applies itself to the holes under the pipes, and thus stops the passages.

We now come to describe the apparatus which opens the valves, *h*, at the proper time, to perform the note of a piece of music.

The axle, on which the crank, *a*, (fig. 1, 2, and 3) is formed, has an endless

screw, *o*, (fig. 3,) cut upon it to turn a wheel, *p*, by the teeth cut in its circumference; this wheel is in the same piece with a cylindric barrel, H H, shown separately (in fig. 4, Plate II); it has a great number of short pins stuck in it, which as it revolves upon its pivots, catch the ends of a number of small levers called keys, *r r r*, and raise them; this depresses the other, *t t t*, ends, which are attached to the rods, G, and consequently open the valves. There are as many of the levers, or keys, as there are pipes, each answering to a different note of the gamut; the pins in the barrel are so disposed, as to lift the keys in the same order and time as any piece of music for which the barrel has been previously made. The keys all turn upon one wire, as a centre, and to prevent their shifting sideways; and by that means missing the pins in the barrel intended for them, they move in small notches, cut by a saw in two pieces of brass plate, which are screwed to the edge of a piece of wood, K, and project below it; the wire which forms the centre for the keys is also fixed to the piece of wood, K, which is called the key-frame. A number of small pieces of mahogany are fixed to the keys at *t*, and to these the rods, G, are jointed by a piece of leather glued to both: *v v*, are small screws going through the key-frame, and touching the piece of wood, *t*; their use is to adjust the levers, so that the ends, *r r*, shall form one straight line.

The key-frame is not fastened down to the frame of the machine, but has a piece of iron plate, *w*, fastened to each end, and turning upon screws fixed to the frame of the instrument, upon which the whole key-frame can be fitted as a centre; two screws through its ends, resting their points upon the frame, support it, and by screwing these out, the whole frame can be raised or lowered, to adjust the ends of the keys the proper distance from the centre of the barrel, H.

By inspecting the plan and elevation, (fig. 1 and 3) it will be seen, that the barrel is longer than the set of keys, by the distance of one of the keys from the other; the barrel can be moved along endways this quantity, and for this purpuse it is mounted in a frame, (fig. 4) which slides in a groove, shown in the section (fig. 2); a small pin, P, (fig. 4) is fastened to the frame, and comes through the case of the instrument; it has notches cut in it, which receive the sharp edge of a bolt, L, (fig. 7) fixed there, and which holds the barrel in any place it is set. By moving the barrel endways a short distance, an entire new set of pins is presented to the keys, *r r*, which pins are disposed differently to the former ones, and consequently play a different tune; there are often five different sets, and as many notches, on the pin, P, (fig. 1.) Without some contrivance when the barrel is moved endways, its pins might catch some of the keys, and break or bend them: to avoid this, the bolt, P, which confines the barrel, and prevents it being moved either way, is held down by another bolt, R, (fig 7) sliding across the end of it; this bolt has a pin fastened to the back of it, which goes through the case of the instrument, (marked *x*, fig. 2 and 3) and when drawn back, presses down the end of a lever *y*, the other end of which lifts up the key-frame, and thus raises the keys up clear of the pins in the barrel, before it can be moved endways to play another tune.

The regulator, D, is pressed down by two wire springs, which equalize the pressure upon the air contained in it, when, by the bellows forcing in more air than the pipes require, and consequently it accumulates in the regulator, it lifts up its lid, and the handle of a small valve, *z*, seen in the elevation, (fig. 1) is pushed against a part of the frame; this opens the valves, and allows the air to escape, until the regulator sinks by the action of the two wire springs.

From what we have said, a description of the operation of the instrument will be scarcely necessary. By turning the handle, the crank, *a*, works the bellows, and supplies the air to the pipes; the endless screw turns the barrel, and its pins lift up the keys at the proper time, opens the valves, and admits the air into the pipes. When soft music is to be played, the stop, *m*, (fig. 2) which has a handle coming through the case, is drawn out, and the other shoved in; this stops the passages to the wooden pipes, and opens the metal ones; for fuller music, the stop, *m*, is pushed in, and *n* drawn out; the wooden pipes are then used, and, for very grand and loud music, both sets are used, by drawing out both stops, and when both are in the sound-cases, though the handle is still turned. For changing the tune, the bolt, R, is drawn back, this raises the key-frame;

the other bolt is then drawn back, and the pin, P, moved in or out to another notch; the bolts are then to be returned. Several barrels are adapted to the same organ, to perform a great variety of tunes.

ORGANICAL, in the ancient music, was that part performed by instruments. The organical comprehended three kinds of instruments, *viz.* the wind instruments, as trumpets, flutes, hautboys, &c.; stringed instruments, as lutes, lyres, violins, harpsichords, &c.; and pulsative instruments, or those played by beating with the hands or sticks, as drums, &c.

ORGANICAL *description of curves*, is the description of them upon a plane by means of instruments, and commonly by a continued motion. The most simple construction of this kind is, that of a circle, by means of a pair of compasses. The next is that of an ellipse, by means of a thread and two pins in the foci, or the ellipse and hyperbola, by means of the elliptical and hyperbolic compasses.

ORGANZINE, in commerce, a description of silk usually imported from Italy into this country. It is of the utmost importance to the manufacturer, as none of the principal articles could be fabricated without it; and the Italians aware of this, long kept the art of throwing it a most profound secret. It was introduced into this country by the enterprize and skill of Messrs. Thomas and John Lombe, the latter having at the risk of his life, and with wonderful ingenuity, taken a plan of one of these complicated machines, in the King of Sardinia's dominions, from which; on his return, they established a similar set of mills in the town of Derby; and in consideration of the great hazard and expense attending the undertaking, a patent was granted to Sir Thomas Lombe, in 1718, for securing to him the exclusive privilege of working organzine for the term of 14 years; but the construction of buildings and engines, and the instruction of the workmen, took up so much time, that the 14 years were nearly expired before he could derive any advantage from it, in consequence of which he petitioned parliament, in 1731, to grant him a further term; but parliament considering it an object of national importance, granted him the sum of 14,000*l.* on condition that he should allow a perfect model of the machinery to be taken, and deposited in the Tower of London, for public inspection. Similar mills were, in consequence, set up in different parts of the country; but owing to the difficulties that were experienced in procuring raw silk of the proper size for organzine, the exportation of which from Italy was prohibited, and to the mills having subsequently found employment for other purposes, the quantities worked into organzine, for many years, bore scarcely any proportion to the imports from Italy; it has, however, been since revived and improved, in consequence of which it is now carried to a very considerable extent.

The process which the silk undergoes to bring it into this state, consists of six different operations: 1. The silk is wound from the skein upon bobbins. 2. It is then sorted. 3. It is spun, or twisted, on a mill in a single thread. 4. Two threads thus spun are doubled, or drawn together through the fingers of a woman, who at the same time cleans them, by taking out the slubs which may have been left in the silk by the negligence of the foreign reeler. 5. It is then thrown by a mill, that is, the two threads are twisted together either slack or hard, as the manufacture may require; and it is wound at the same time in skeins upon a reel. 6. The skeins are sorted, according to their different degrees of fineness, and then the process is complete.

Organzine was for many years made only from Italian silk, but when considerable improvements were made in the culture of silk in India, it suggested the possibility of throwing some of the finer silks of Bengal into organzine. The experiments of individuals were not very satisfactory, but in the beginning of 1794, the East India Company took up the subject, with the view of increasing the annual consumption of Bengal silk in this country; and having it in their power to select from their total import the silks most proper for this purpose, they have been enabled, at each subsequent sale, to put up from 80 to 100 bales of good Bengal organzine. It has been adopted successively in several branches of the manufacture; and in the year 1808, when the prohibition of exportation from Italy produced a scarcity of the silks of that country, attempts were made to substitute Bengal organzine for all the purposes to which Italian organzine was applied; the result, however, appeared to be that, for some particular articles, Italian organzine possesses pecu-

liar properties not to be found in any other kind of silk.

ORGASM, a quick motion of the blood, whereby the muscles are made to move with great force.

ORGUES, in the military art, are thick long pieces of wood pointed at one end, and shod with iron, clear one of another; hanging each by a particular rope, or cord, over the gate-way of a strong place, perpendicularly, to be let fall in case of an enemy. Their disposition is such, that they stop the passage of the gate, and are preferable to herses or portcullises; because these may be either broke by a petard, or they may be stopped in their falling down; but a petard is useless against an orgue, for if it break one or two of the pieces, they immediately fall down again, and fill up the vacancy; or if they stop one or two of the pieces from falling, it is no hindrance to the rest.

ORIGANUM, in botany, *marjoram*, a genus of the Didynamia Gymnosperma class and order. Natural order of Verticillatæ. Labiatæ, Jussieu. Essential character: strobile four-cornered, spiked, collecting the calyxes. There are twelve species, with several varieties.

ORILLON, in fortification, is a small rounding of earth faced with a wall; raised on the shoulder of those bastions that have casements, to cover the cannon in the retired flank, and prevent their being dismounted by the enemy.

ORIOLUS, the *oriole*, in natural history, a genus of birds of the order Picæ. Generic character: bill conic, convex, very sharp and strait; mandibles equally long; nostrils small, and lodged in the base of the bill, and partly covered; tongue divided and sharp-pointed. These birds are natives of America, are clamorous and voracious, appear in flocks, feed on fruits and grain, and frequently have pensile nests. Latham enumerates forty-five species; Gmelin fifty. We shall notice only those which follow:

O. persicus, or the black and yellow oriole. A variety of this species, somewhat larger than a blackbird, and an inhabitant of South America, is the bird rendered remarkable for building nests in the form of an alembic, and nearly eighteen inches long, of dry grass, hog's bristles, and horse-hair, or, what is called in that country, old man's beard, a substance very like the hair of horses. The bottom of this nest is hollow for the length of a foot, the remainder or upper part, for the space of six inches, is solid, and it is suspended at the extremity of a branch. It is particularly fond of building on trees, near houses, and several hundreds of these nests have occasionally been seen on a single tree.

O. icterus, or the Banana bird, is found in all the Caribbee islands, feeding on insects, and hopping like a magpie. These birds are domesticated in America, for the destruction of insects. In a state of nature, four or five will attack a large bird, and appear, after tearing it in pieces, to divide the spoil with great discrimination. They will occasionally attack men. Their nests are formed and suspended like those of the former species, to guard against snakes and other animals.

O. Baltimoreus, or the Baltimore bird, is called by the natives, the fire-bird, and, when its feathers are most brilliant, naturally excites the idea or sensation of fire. These birds form pensile nests, secure from all depredation. They are about seven inches long, and inhabit North America.

O. galbula, or the golden oriole, is as large as a blackbird, and of a fine golden yellow, with wings almost entirely black. It is common in several parts of Europe, particularly in France; but not seen so far north even as England. It is supposed to winter in Africa. Its nest is pensile, and the female is extremely attentive to her young, fearing no enemy in their defence, suffering herself to be taken in the nest with them, and continuing to sit over them in the cage till she dies. It feeds on insects and fruits, and is considered as a delicacy for the table.

For the red-rumped oriole, see Aves, Plate X. fig. 6.

ORION, in astronomy, a constellation of the southern hemisphere, consisting of thirty-seven stars, according to Ptolemy; of sixty-two, according to Tycho; and of no less than eighty, in the Britannic catalogue. The lately improved telescopes have discovered several thousand stars in this constellation: of these, there are two of the first magnitude, four of the second, and several of the third and fourth. The stars of the first magnitude are Regel and Betelguese. Those of the second are, Bellatrix, on the left shoulder, and three in the belt, lying nearly in a right line, and at equal distances from each other.

ORNITHOGALUM, in botany, *Star of Bethlehem*, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Asphodeli, Jussieu. Essential character: corolla six-petalled, upright, permanent, spreading above the middle; filaments alternate, widening at the base. There are thirty-five species.

ORNITHOLOGY, that branch of natural history which considers and describes birds, their natures and kinds, their form, external and internal, and teaches their economy and uses; see AVES: also the several orders and genera in the alphabetical order. Birds are divided, according to the form of their bills, into six orders, *viz.* Accipitres, as eagles, vultures, and hawks: Picæ, as crows, jackdaws, humming-birds, and parrots: Anseres, as ducks, geese swans, gulls: Grallæ, as herons, woodcocks, and ostriches: Gallinæ, as peacocks, pheasants, turkies, and common fowls: and Passeres, comprehending sparrows, larks, swallows, &c.

Birds are distinguished from quadrupeds by their laying eggs: they are generally feathered; some few are hairy, and instead of hands or fore-legs, they have wings. Their eggs are covered by a calcareous shell, and they consist of a white, or albumen, which nourishes the chick during incubation; and a yolk, which is so suspended within it as to preserve the side on which the little rudiment of the chicken is situated continually uppermost, and next to the mother that is sitting upon it. The yolk is in great measure received into the abdomen of the chicken, a little before the time of its being hatched, and serves for its support, like the milk of a quadruped, and like the cotyledons of young plants, until the system is become sufficiently strong for extracting its own food out of the ordinary nutriment of the species.

ORNITHOPUS, in botany, *bird's foot*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: legume jointed, round, bowed. There are five species.

ORNITHORHYNCHUS *paradoxus*, in natural history, a singular quadruped, remarkable for its structure. The head is similar to that of a duck, which would lead to the supposition that it belonged to an aquatic bird. Both jaws are as broad and low as those in a duck, and the calvaria has no traces of a suture, as is generally the case in full-grown birds. In the cavity of the skull there is a considerably bony falx, which is situated along the middle of the os frontis, and the ossa bregmatis. The mandible of this animal consists of a beak, the under part of which has its margin indented as in ducks, and of the proper instrument for chewing that is situated behind, within the cheeks. Dr. Shaw says it has no teeth, though Mr. Home found, in a specimen examined by him, two small and flat molar teeth on each side of the jaws. The forepart of this mandible, or beak, is covered and bordered with a coriaceous skin, in which three parts are to be distinguished, *viz.* the proper integument of the beak; the labiated margins of it; and a curious edge of the skin of the beak. Into these three parts of that membrane numerous nerves are distributed, intended, probably, as the organs of feeling, a sense which, besides men, few mammalia enjoy; that is, few animals possess the faculty of distinguishing the form of external objects, and their qualities, by organs destined for that purpose, a property very different from the common feeling, by which every animal is able to perceive the temperature and presence of sensible objects, but without being informed, by the touch of them, of their peculiar qualities. Thus the skin in the wings of the bat, and its ear, are supposed the organs of common feeling, by means of which they are enabled to flutter, after being blinded, without flying against any thing. The whiskers of many animals appear likewise to serve the same purpose of informing them of the presence of sensible bodies, and hence they have been compared to the antennæ of insects. But to return to the ornithorynchus: it is an animal which, from the similarity of its abode, and the manner of searching for food, agrees much with the duck, on which account it has been provided with an organ for touching, *viz.* with the integument of the beak richly endowed with nerves. This instance of analogy in the structure of a singular organ of sense in two species of animals, from classes quite different, is a most curious circumstance in comparative physiology, and hence the ornithorhynchus is looked upon as one of the most remarkable phenomena of zoology. There are two species, both inhabitants of New-Holland.

OROBANCHE, in botany, *broom-rape*, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx bifid; corolla ringent; capsule one-celled, two-valved, many-

seeded; gland under the base of the germ' There are fourteen species.

OROBUS, in botany, *bitter vetch*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: calyx blunt at the base; the upper teeth deeper and shorter; style linear. There are sixteen species.

ORONTIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Piperitæ. Aroideæ, Jussieu. Essential character: spadix cylindrical, covered with florets; corolla six-petalled, naked; style none; follicles one-seeded. There are two species, *viz.* O. aquaticum, and O. japonicum.

ORPHAN. In the city of London there is a court of record established for the care and government of orphans.

ORPIMENT is a fine yellow powder, formed from a solution of the white oxide of arsenic in muriatic acid, to which is added a solution of sulphuretted hydrogen in water. It may also be obtained by subliming arsenic and sulphur by a heat not sufficient to melt them. It is likewise found native in many parts of Germany and Italy, composed of plates that have a considerable degree of flexibility. Its specific gravity is 5.3. It is used as a pigment. The Chinese fashion vessels of different shapes, and their pagodas, of the mineral.

ORRERY, a curious machine for representing the motions and appearances of the heavenly bodies. See PLANETARIUM.

ORTEGIA, in botany, so named in honour of Joseph Ortega; a genus of the Triandria Monogynia class and order. Natural order of Caryophylleæ. Essential character: calyx five-leaved; corolla none; capsule one-celled; seeds very many. There are two species, *viz.* O. Hispanica, Spanish ortegia, and O. dichotoma, forked ortegia, natives of Spain and Italy.

ORTHOGRAPHIC *projection of the sphere*, that wherein the eye is supposed at an infinite distance; so called, because the perpendiculars from any point of the sphere will all fall in the common intersection of the sphere with the plane of the projection.

ORTHOGRAPHY, that part of grammar which teaches the nature and affections of letters, and the just method of spelling or writing words with all the proper and necessary letters, making one of the four greatest divisions or branches of grammar.

ORTHOGRAPHY, in geometry, the art of drawing or delineating the fore-right plan of any object, and of expressing the heights or elevations of each part. It is called orthography, from its determining things by perpendicular lines falling on the geometrical plane.

ORTHOGRAPHY, in architecture, the elevation of a building. This orthography is either external or internal The external orthography is taken for the delineation of an external face or front of a building; or, as it is by others defined, the model, platform, and delineation of the front of a house, that is contrived, and to be built, by the rules of geometry, according to which pattern the whole fabric is erected and finished. This delineation or platform exhibits the principal wall, with its apertures, roof, ornaments, and every thing visible to an eye placed before the building. Internal orthography, which is also called a section, is a delineation or draught of a building, such as it would appear were the external wall removed.

ORTHOGRAPHY, in perspective, is the fore-right side of any plane, *i. e.* the side or plane that lies parallel to a straight line, that may be imagined to pass through the outward convex points of the eyes, continued to a convenient length.

ORTHOGRAPHY, in fortification, is the profile or representation of a work; or a draught so conducted, as that the length, breadth, height, and thickness, of the several parts are expressed, such as they would appear if perpendicularly cut from top to bottom.

ORYCTOLOGY is the science which teaches the natural history of those animal and vegetable substances which are dug out of the earth, in a mineralized state. In the following slight sketch of the history of these substances it will be seen, that the remarkable situations in which they have been found, and the extraordinary changes which they have undergone, have led to the adoption of various contradictory and absurd notions respecting their nature and origin; which have been corrected, as just ideas have been obtained respecting the formation of the earth itself. Xenophanes, more than 400 years before Christ, was led to the belief of the eternity of the universe, by discovering the remains of different marine animals imbedded in rocks, and under the surface of the earth. Herodotus ascertained the existence of fossil shells in the mountains of Egypt, and was thereby induced to conclude, that the sea must have once covered those

parts. In the pyramids of Egypt, mentioned by this author, and which had been built at so early a period that no satisfactory accounts could be derived from tradition respecting their erection, the stones were found to contain the remains of marine animals, and particularly of such as exist no longer in a recent state, and differ essentially from all known animals. These were supposed by Strabo, who saw the fragments of these stones laying around the pyramids, to be the petrified remains of the lentils which had been used for food by the workmen. Eratosthenes, Xanthus of Lydia, and Strabo, have all noticed and variously commented upon the existence of animal remains thus wonderfully preserved. In the works of Pliny many fossil bodies are mentioned; particularly the bucardia, resembling an ox's heart, but which was doubtlessly a cast formed in a bivalve shell; glossopetra, bearing the form of a tongue, and supposed to fall from the moon, when in its wane; hammites, resembling the spawn of fish; horns of ammon, resembling, in form, the ram's-horn; lepidotes, like the scales of fishes; meconites, bearing a resemblance to the seeds of poppies; brontia, to the head of a tortoise; spongites, to sponge; phycites, to sea-weeds or rushes, &c. Although many were convinced, by the exact resemblance which several of these substances bore to different species of marine animals, that these must be the remains of such animals, and must have been deposited on these spots, at a period when they were covered by the sea; others, unable to comprehend a circumstance so inexplicable as the existence of the sea over some of the highest mountains, chose rather to have recourse to an apparently more easy mode of explanation, by attributing their formation to the energies of certain occult powers, such as the *vis plastica*, *vis formativa*, and *vis lapidificativa*.

The formation of these bodies was also attributed, by our countryman, Dr. Plot, to certain plastic powers inherent in some saline bodies; and Dr. Woodward, one of our latest writers on these substances, although aware that the situations, in which these bodies were found, could only be explained by the powerful and extensive effects of the deluge, found himself obliged also to have recourse to an occult plastic power, to explain the formation of some of these substances. "There are," he observes, "various phenomena that plainly shew that, when they were brought forth at the deluge, the earth was destroyed, all the solids of it, metals, minerals, stone, and the rest, dissolved, taken up into the water, and there sustained along with the sea-shells, and other extraneous bodies; till at length all settled down again, and formed the strata of the present earth. The shells, and other extraneous bodies, being thus lodged among this stony and other mineral matters, that afterwards became solid: when this comes now to be broke up, it exhibits impressions of the shells, and other bodies lodged in it; showing even the hardest of it to have been once in a state of solution, soft, and susceptible of impression." (Preface to Catalogue of English Fossils, p. 3.) But unable otherwise to oppose the opinion of Dr. Buttner, that the fossil corals were actually corals which had existed before the flood, he had recourse to the supposition of their having derived their forms from a second arrangement of their component parts, whilst in the waters of the deluge. "I have seen," he says, "fossil coralloids that have been composed of various sorts of mineral and metallic matter, that yet have been formed into shape of the marine mycetitæ, astroitæ, and other like corals. Now all these have been formed out of the dissolved mineral and metallic matter in the water of the deluge. The antediluvian corals were like all other solid stony bodies then in solution in that water, and might concrete again and form true corals there as well as in the sea water. Doubtless it did so; but that matter was in so small a quantity, and bore so little a proportion to the mineral and metallic, with which it was then mixed and confused, as now rarely, if ever, to be met with." (Letters on Fossils, by Dr. Woodward, p. 82.) At present, no one hesitates at considering all organized fossil bodies as having existed during a former state of this globe, and having been then endued with the energies of vegetable or animal life.

Various appellations have been employed for the purpose of distinguishing these bodies from those minerals which do not owe their forms to animal or vegetable organization.

Figured stones (*lapides figurati et idiomorphi*) and diluvian stones (*lapides diluviani*) were terms well chosen by the earlier mineralogists to designate these bodies, of the peculiar forms of which, and of their having probably obtained those forms from some changes depending on the deluge, they only could, with any propriety, speak. The term fossil

comprising every mineral substance dug out of the earth, it was thought necessary to distinguish these by the term adventitious or extraneous. To this generally adopted mode of distinction, Mr. Parkinson (Organic Remains, vol. i. p. 34,) objects.

The term extraneous, he observes, denotes that the substance spoken of is foreign to the region in which it is found; a sense in which, he thinks, it cannot, with propriety, be applied to such bodies as are almost deprived, not only of their primitive form, but of their original constituent principles. In these cases, where so considerable a degree of naturalization, as it were, has taken place, the substance, he conceives, can no longer merit an epithet implying their being foreign to the regions in which they are found. Instances of the impropriety of this employment of the term he instances in such of the jaspers and semiopals as have derived their origin from wood; to which the epithet of extraneous does not appear to be strictly applicable. The term adventitious, as implying the result of chance or accident, he thinks ought never to be applied to these substances; since, in all nature's works, there exist not stronger proofs of the provident design of the Almighty Creator, than in the apparently casual disposition of these substances. To the term petrifaction he objects, because a conversion into stone only is here expressed; whereas, in many instances, the substances of which the fossil is composed differs as much from stone, as from the matter of which the body was originally composed. Fossils he considers as of two kinds, primary and secondary; among the former he places those bodies which appear to have been, *ab initio*, the natives of the subterranean regions: and under the latter he disposes those substances, which, though now subjects of the mineral kingdom, bear indubitable marks of having been originally either of an animal or vegetable nature. The term fossil, however, which implies that the organized substance under examination has been dug out of the earth, appears to be sufficient, without any adjunct to express these substances; indeed this term is warranted to be thus employed by its general acceptation.

Besides those bodies which, being actually organic remains, deserve to be considered as fossils, (*fossilia, vulgo dicta* of Linnæus;) other bodies require to be noticed, as sometimes serving to illustrate the nature of organised fossils. These are, impressims, (*impressa*, Linnæus; *typolithi*, Waller); Casts, (*redintegrata*, Linnæus); and incrustations, (*incrustata*, Linnæus.)

Fossils naturally divide into vegetable and animal, according to which of those kingdoms they originally belonged; those of the vegetable kingdom shall be the first subjects of our inquiry.

The parts of vegetables confined in subterranean situations suffer, according to circumstances, either a complete resolution of composition, the lighter parts becoming volatilized, whilst the more fixed remain and form the substance which is termed mould (*humus*); or, as is supposed by Mr. Parkinson, it passes through another process, which he considers as fermentative, and becomes bituminous. Wood, thus changed, is called lignum fossile bituminosum, surturbrand, and Bovey coal. By the extension of this process, the same author supposed, that the substances termed bitumens, (naphtha, petroleum, and asphaltum), are formed. To the same process he also attributes the formation of amber, of which however no proof appears. That jet, cannel coal, and the common coal employed in domestic uses, have had a vegetable origin, is rendered highly probable, from the frequency with which they manifest the impressions of various vegetable bodies.

Thus, perhaps, the formation of the bituminous fossils may be satisfactorily explained: but by far the greater number of vegetable fossils are of a lapideous nature, and necessarily owe their formation to very different processes; which the same author supposes are, in general, preceded by the process by which bitumen is formed. Many bodies which are evidently of vegetable origin may be now found existing in a lapideous, either calcareous or silicious, state; and many others are found possessing certain marks of the presence of some metallic substance.

To explain these formations, various opinions have been formed. Some have supposed the injection of the impregnating matter, in a state of fluidity, by ignition; whilst others have imagined the gradual abstraction of the original particles of the body, and the regular deposition of the impregnating particles in the spaces which have just been left by the original matter. Mr. Parkinson, who does not admit of this substitution, attributes the formation of this description of fossils to the impregnation of vegetable

substances, which have undergone different degrees of bituminization, with water, holding the earths or the metals in solution. Thus with lime is formed the calcareous wood or wood-marble of Oxfordshire and Dorsetshire, of Piedmont and of Bohemia; with silex is formed the calcedonified, agatified, and jasperified wood (Holzstein); and with the addition of alumine, &c. the fossil woods which now partake of the nature of pitch-stone, and waxopal (Holzopal). In other situations, metallic impregnations occur; as in such woods as are impregnated with the pyrites of iron, so frequently found in our islands; and the beautiful woods of Siberia, containing the hydrate and carbonate of copper.

Various parts of trees and plants (phytolithi) are found in a mineralized state. Not only fossil wood (lithoxylon), as has been just noticed, but the leaves (lithopylla or lithobiblia), and fruits (carpolithi) of different trees or plants are thus found. Of the woods, several, from their form and texture, have been supposed to have been originally oak, willow, and such trees as now exist in a recent state; whilst others differ, in both these respects, from any species of wood which is now known.

The impressions of the stalks and leaves of plants are very frequently found in many parts of the world, in lofty mountains, as well as at a considerable depth below the surface; and not only the impressions, but the substance itself of different vegetables are also thus found; but in no situation more frequent than in the neighbourhood of coal mines.

In general these vegetable remains are found deposited in lamina, in the schistose strata which accompany the coal; but the most perfect remains are commonly found in roundish nodular masses of ferruginous clay, which abound in the strata accompanying the coal. These are commonly termed catsheads by the workers of the coal mines, and contain pieces of fern, &c. very few, indeed, of which are found to agree with any known recent plants. One of these plants, preserved in coal slate, is shewn, Plate I. Oryctology, fig. 1. The vegetable remains in these fossils appear to confirm the opinion above mentioned, of the bituminization of fossil vegetables; since these leaves are completely changed into a bituminous substance.

The remains of fruits are, perhaps, no where found so abundantly as in the Isle of Sheppey, where they are dug up in great variety; very few, however, being found which agree with any known recent fruits. Where any resemblance appears, it is with fruits which only grow in the warm Asiatic regions. Plate I. fig. 2, represents a fossil fruit which was found in the cliff of Sheppey.

Fossil roots of plants of trees are very rarely found; a circumstance not very easily explained; since they possess (especially the roots of trees) that degree of solidity which appears to be favourable to the process of petrifaction. From the want of this necessary property it undoubtedly is, that we possess so few remains of tender flower leaves, and none of pulpy fruits.

From the same cause, the great proneness to decomposition, the number of animal fossils is considerably limited: those substances being only preserved in a mineralized state which originally possessed a considerable degree of solidity; such are the bones, teeth, horns, shells, scales, &c. The animal, however, far exceeds the vegetable kingdom in the number and variety of fossils which it yields, as well as in the distinctness of form, and excellency of preservation, in which they are found.

Adopting in a great measure the arrangement of Waller, we shall commence our examination of the animal fossils with those which have derived their origin from corals. These fossils are, of course, merely the remains of the dwellings which have been formed by the various coral insects, and which are so frequently found in the cabinets of the curious.

Immediately on commencing this examination, we are struck with a similar want of agreement between the recent and fossil corals, with that which has been noticed between recent and fossil vegetables. Of the genus Tubipora it does not appear, at least by the observations made in Mr. Parkinson's second volume of "The Organic Remains of a former World," that a single species which is known recent has been found as a fossil. Several fossil species are, however, described, of which nothing similar is known in a recent state. The most striking of these is the Tubipora catenularia, or chain coral, the surface of which, in consequence of the tubes being in contact at their sides, has frequently a very curious reticulated or catenulated appearance. Plate I. fig. 4, repre-

sents this fossil in its usual state: and at fig. 5 is shewn the appearance yielded by a transverse section. Tubipora fascicularis, T. stellata, T. repens, and T. strues, which have been described by different authors, and which are unlike to any known recent Tubipore, give reason for supposing that the number of species of fossil Tubipores exceeds that of the recent species.

The fossil Madrepores are not less rich in variety, nor less comparatively numerous, than the fossils of the preceding genus. The forms of several species of the fossil Madrepores do frequently approach to those of the different recent species; but in a considerable number of the fossil Madrepores no resemblance is discoverable, except in their stelliform openings, with any recent coral. So great indeed is this departure in some instances from the general characters of our present known Madrepores, that it has been deemed difficult to determine, whether some fossil specimens should be considered as Madrepores or as Alcyonia. It is impossible, without the aid of numerous figures, to give satisfactory notions of the forms of the several fossil Madrepores which have been hitherto discovered; the most interesting only will therefore be here particularized.

The Madrepores consisting of a single star appear to be much more numerous in a mineral than in a recent state. These are either of a discoidal form, having a concave superior and a convex inferior surface; of a pyramidal top-like form, terminating in a pedicle; or of a lengthened pyramidal form, bearing in some, from a slight curvature, the appearance of the horn of an animal; whilst others are cylindrical for a considerable part of their length.

The first of these, Madrepora porpita, the shirt-button Madrepore, has been long known to the collectors of fossils in this kingdom. Dr. Woodward describes several of them, as mycetitæ discoides. The second species (Madrepora turbinata) is also frequently found in different parts of Great Britain, as well as in Sweden, Norway, and in several parts of France, Switzerland, and Italy. These latter fossils have been termed by Dr. Woodward mycetitæ conoides seu calyciformes. When they have acquired somewhat of a hornlike shape, they have been distinguished by the term ceratites; and when they have possessed more of the cylindrical form, they have been termed columelli lapidei et hippuritæ; and from a supposed resemblance, they have been also considered as the petrified roots of briony. Some of the single starred corals are found united at their pedicle, and approaching towards each other at their summits, though disjoined nearly through their whole length. These, from their resemblance to petrified reeds, have been named junci lapidei.

It would be useless to attempt, in this sketch, to specify the considerable variety of fossil Madrepores formed of aggregated circular stars, and which have been designated as astroites, &c. Those which are composed of angulated stars are, perhaps, not so numerous: many of these, however, are very different in their appearance from those which are known in a recent state. The one most known in these islands is the lithostrotion, sive basaltes striatus et stellatus, of Llwyd; the exact union of the sides of the polygons giving a tolerably correct idea of minute basaltes. The compound Madrepores, the stelliform part of which are extended in undulating labyrinthean forms, appear to be much less numerous as fossils than any of the other corals: their existence in a silicious state very rarely occurs.

The Milleporæ do not appear to be nearly so frequently found in a mineral as in a recent state. Several fossils have been placed among the Millepores, which undoubtedly should rank with the Madrepores: such are the Millepora simplex turbinata, and the Millepora simplex discoides, of Waller and Gesner; a careful examination shewing, that these differ from the porpital and turbinated Madrepores only in their being formed of numerous tubes, possessing an internal stellated structure.

Of the genus Isis one species only appears to be known as a fossil. This species was at first described by Scilla, who at first conjectured it to be the leg-bone of some animal. Specimens are frequently found in the Calabrian mountains, and have lately been also found in some parts of Wiltshire. Of the genus Cellepora, Antipathes, and Gorgonia, fossil specimens appear to be rather uncommon.

The Corallo Fungitæ of Waller are evidently the fossil remains of Alcyonia. These have been long described by Volkmann, Scheuchzer, and others, as fossil fruits, and have obtained, from their resemblance to figs, &c. the appellations of ficoides, caricoides, &c.; whilst others

of a different form have been named lycoperditæ, fungitæ pilcati, &c. A fossil Alcyonium has even been described by Volkmann and Scheuchzer as a fossil nutmeg. A fossil Alcyonium of a conical form is represented, Plate I. fig. 6.

The Encrini and Pentacrini have been always, and very properly, considered as the most curious of the fossil Zoophytes. The Encrinus (Plate I. fig. 3) possesses the distinguishing character of having its spine, or, as it has been generally called, its tail, composed of cylindrical or orbicular vertebræ, pierced through their centre, and marked with diverging striæ on their articulating surfaces. On the superior termination of these is placed the base of the body of the animal, formed of five trapezoidal bodies, termed by Rosinus articuli trapezoides, which inclose five small bodies, which form the centre of the base; the whole of these forming that which Rosinus denominated the pentagonal base. From each of these proceed six other bodies, on the two last of each series of which are placed the arms of the animal, which divide into fingers; from the internal surface of these proceed almost innumerable articulated tentacula. This fossil has long possessed the name of the Encrinus, or stone lily; its resemblance to that flower having led to the suspicion that it was a petrifaction of a flower, approximating in its form to the lily: its animal origin is however now completely ascertained. Indeed, if a doubt had remained, it would have been removed by the circumstance of the animal membrane, or cartilage, having been actually discovered in the fossil, ("Organic Remains of a former World," vol. ii. p. 166.) Several other species of this animal are also described in the work just referred to; but hitherto no recent animal has been found which can be referred to this genus.

The fossil Pentacrinus differs from the Encrinus, in its vertebræ being of a pentagonal form, and in its arms, fingers, and tentacula being capable of being much more widely spread and extended than are those of the Encrinus. It appears from Mr. Parkinson's account, that there are several species of this fossil, the existence of some recent species of which have been also ascertained.

The encrinital vertebræ (Plate I. fig. 7 *a*) have been hitherto termed trochitæ when separate, and entrochi when connected in a series, (Plate I. fig. 7.) The single vertebræ of the Pentacrinus have been distinguished as asteriæ, (Plate I. fig. 8 *a*); and when united together they have been termed columnar asteriæ, (Plate I. fig. 8.)

Of the Asteriæ, or Stellæ Marinæ, some very few specimens have been found fossil; but they occur very rarely, and have, in general, been found in a condition too imperfect to allow of any positive opinion being formed, respecting the species to which they belong.

The fossil Echini are very numerous, upwards of forty species, known only as fossils, being enumerated by the illustrious Linnæus; to delineate, therefore, even those most deserving of notice could not be here well accomplished; a circumstance, however, which is not so much to be regretted, since, though materially different, they approach very nearly in their general form to the recent species. Those which possess a hemispherical, or a nearly orbicular form, with large mamilla-like protuberances, and the anus disposed vertically, have been distinguished as the turban echini (*echini cidares*); those which resemble a shield or buckler in their figure, are termed the shield echini (*clypeii Kleinii*); and one of the largest of these has been named the polar stone by Dr. Plot (Plot's Oxfordshire, p. 91.) When of a depressed circular form, with the anus in the edge of the inferior part, they are the fibulæ of Klein; of a conical form, the eagle-stone of the Germans (*conuli, Kleinii*); with a circular base, the quoit echinus (*discoidei, Kleinii*). When the base is an acute oval, the mouth and anus being at the opposite ends, they are termed the helmet echinis, (*cassides et galeæ, Kleinii*); and when heart-shaped, with a sulcated superior surface, they are called snake's hearts (*spatangi, Kleinii.*)

The attempt to particularize the various species of fossil shells which have been found would require a large volume: all that can be here done is to notice some of those which totally differ from any which exist in a recent state, and to offer some few remarks on those which approximate, or are perhaps similar to some of the species which are known in a recent state.

With respect to the state in which fossil shells are found, it is necessary to remark, that, in some situations, shells which have been buried for ages, by the natural changes which the surface of the earth has undergone, are found very little changed, except from the loss of colour, and having been rendered extremely fragile; that in other situations the substance of the shell has been so injured, as to be reduced to very small fragments, and

even to a very fine powder, leaving in some instances a stony, correctly moulded, cast of the cavity of the shell; that very frequently the substance of the shell is entirely altered, having become a calcareous stone, or a silicious or pyritous mass, and that the shells of a former world are frequently found in masses of marble, which is called lumachelli, or shelly marble.

Of the Multivalves, the chiton does not appear to have been found in a mineralized state; and although several species of Lepas have been found in a mineral state, they are by no means frequent fossils. Lepas anserifera is said to have been found fossil, as well as Lepas diadema; these must, however, be exceedingly rare fossils.

Fossil shells of the Pholas are by no means common; the Pholas crispata has been, however, found among the Harwich fossils.

Fossil bivalves are very common fossils; they are, as might be expected, very seldom found in pairs, except when united by a lapideous mass, which prevents the examination of their hinge, or their internal structure, which in many fossil shells are objects highly worthy of examination.

The Mya pictorum is described by Solander as existing among our Hampshire fossils: a fossil mya of three or four inches in length, is found also in the rocks near Bognor. Remains of the solen siliqua, and of the solen ensis, have been found at Harwich, and a small fossil shell, named by Solander solen ficus, has been found between Lymington and Christchurch.

Fossil shells of the genus Tellina, as well as of cardium, mactra, donax, venus, spondylus, chama, arca, and particularly ostrea, have been found of many species. But no bivalve exists as a fossil in such prodigious numbers, and in such various species, as those of the genus Anomia. These shells are characterized by the beak of the largest or under valve, which is perforated, being greatly produced, rising or curving over the beak of the smaller or upper valve. Anomia lacunosa (Plate II. fig. 1.) is one of the most abundant of these species. They are found in considerable quantities in different parts of England, particularly in Lincolnshire, Warwickshire, and Gloucestershire. Anomia terebratula, (Plate II. fig. 2), is another fossil of this genus, which exists in different counties in this island, in great abundance.

Of the genus Mytilus several species are known as fossils, some of which approach very near to those which are known recent: one in particular appears to differ very little indeed from Mytilus modiolus. Fossil shells of the genus Pinna, in any tolerable preservation, are not frequently found: the shells are in general so fragile as to render it very difficult to obtain them tolerably perfect; or so that but little information can be yielded respecting the species to which they belong.

No fossil shell appears yet to have been found which can with certainty be placed under the genus Argonauta. But of the genus Nautilus, specimens are very frequent. These have been found in several parts of this island: some very fine specimens have been found at Lime in Dorsetshire, in different parts of Wiltshire, and at Whitby in Yorkshire. The finest specimens are perhaps found in the neighbourhood of Bath, and in the Isle of Sheppey in Kent, at which latter place they are found exceedingly large, and still retaining a resplendent pearly shell. (Plate II. fig. 3.)

The Cornu Ammonis, which, if we except the extremely minute shells of this kind which have been seen by Plancus, and others, in the sea sand on the Venetian shores, may be said to be only known to us in a fossil state

Like the Nautilus, the Cornu Ammonis is divided into compartments, by regularly disposed partitions, and these partitions are perforated, as are those of the Nautilus, although it is by no means easy to point this out, except in very few specimens.

There are none of the fossil shells, except perhaps the Anomiæ, which can vie in the variety of their species with the Cornu Ammonis. The shell of some is perfectly smooth over its whole surface; in others smooth at the sides, but ridged or beset with spines at the back; and others, though smooth at the side, are crenulated at the back. The species most commonly met with have the shell variously ridged; some with small close striæ, and others with large and round ridges. In some the ridges are single, in others bifurcated, and in others trifurcated. In some, and these are least common, the shell is tuberculated: these tuberculæ differing considerable in different species, in their size, form, and disposition. The different species proceeding from the intermixture of all these varieties, it must

be obvious, must be exceedingly numerous: Scheuchzer was able to determine the existence of one hundred and forty-nine species. The difference of size observable in these fossils is not less remarkable than the variety of their forms, some being found not much larger than the head of a pin, whilst others have been found as large as the top of a small table.

A peculiar appearance is observable on the surface of many of these fossils, which depends on the peculiar form of the septa which separate the chambers of the shell. These septa in the nautili are smooth, and terminate at the surface of the shell in a straight line; but in the Cornua Ammonis they become undulated as they extend outwardly; and in some so much so as to form, on the outer surface, deeply crenulated lines, giving the appearance of foliaceous sutures. When the cavities of the shell have become filled with stone, and the septa just mentioned have been removed, as is frequently the case, by some chemical agent, the casts formed in the chambers separate, each forming a curiously figured stone; these separate casts have been termed spondilolites. (Plate II. fig. 4.) By the junction of these are formed the foliaceous sutures above-mentioned. The Cornua Ammonis were formerly called serpent-stones; the appearance which they yield of a serpent coiled having led the vulgar to consider them as petrified serpents.

The fossil Cones are very few when compared with the numerous species known in a recent state; the same may be also said of the Cypreæ. In both these genera the species are mostly made out more from the colour and the markings of the shells, than from the peculiarities of their form; but in the fossil shells the colours no longer exist, and of course the species in these can very seldom be presumed. The fossil Volutes, as far as can be judged from their form alone, differ generally from the recent species. With respect to the genus Buccinum, Strombus, and Murex, the number of species of the fossil shells do not appear to equal those which are known in a recent state. This is the case also, in a still greater degree, with the genus Trochus. The fossil shells of the genus Turbo are pretty numerous, and some of them very closely resemble those of known recent species. One fossil shell of this genus is very remarkable for its vast size, being upwards of a foot in length. The cast of another species is so large as to weigh four or five pounds. Nothing like this occurs with respect to the species of the genus Helix: the fossil shells of this genus very much resemble those which are recent, and are not found of any considerable magnitude. The fossil shells of the genus Nerita by no means display so many species as the recent; but some of the fossil species far exceed the recent in size, and one in particular is twelve times the size of any known recent species. Of the genus Haliotis, it is not positively determined that a single shell has been seen, which could be considered as fossil. Fossil shells of the genus Patelta are by no means common. Several species have, however, been found in France, in a state of excellent preservation. Some few also have been found in the cliffs at Harwich, and others, of a different species, imbedded in the lime-stone of Gloucestershire. Dentalia, apparently similar to existing species, have been found in Hampshire, and in some parts of France and Italy, exceedingly well preserved. In Italy, also, have been found specimens of Serpulæ, very similar to those which are known recent; but others have been found in France exceedingly different from any known recent species.

The Orthoceratites, a lapidified conical or cylindrical chambered shell, the septa dividing the chambers of which are perforated like those of the Nautilus, is a genus of which not a species is known in a recent state, excepting the microscopic specimens found by Plaucus in the sand of the Riminian shore. Much is wanting to complete the history of this fossil, since from the state in which the specimens have in general been found, very few, or perhaps none, have been obtained perfect. Authors have divided them into those which are straight (Plate II. fig. 8.), and those which have a spiral termination, the latter of which are considered as fossil shells of the Nautilus lituus; but the extraordinary disparity of size is sufficient to shew that they can hardly be considered of the same species, the recent shell being seldom more than an inch in length, whilst the fossil is described as being sometimes the size of a man's arm.

The Belemnite (Plate II. fig. 7.) is a spathose radiated stone, generally conical, but sometimes possessing a fusiform figure, and contains, in an appropriate cavity at its larger end, a smaller calcareous body (*alveolus*) which has evidently been a concamerated shell, the septæ of which are pierced like those of the preceding fossil. These fossils are from an eighth of an inch to two inches in thickness, and from an inch to a foot and a half in length.

They are sometimes found imbedded in chalk or limestone, and sometimes in pieces of flint; but they are most frequently detached from their matrix. Various have been the opinions respecting this fossil; some have considered it as the horn of a narwhal, and others as a concretion formed in the pennicilla marina, or in some shell of the dentalium kind. Some have even supposed it to be of vegetable origin, whilst others have considered it as entirely belonging to the mineral kingdom. But that the Belemnite originally existed in the sea, is evident from its being commonly found with the remains of the undoubted inhabitants of the ocean, and that it is of an animal nature, is rendered evident by its structure. Among the concamerated fossil shells may be placed the Helicites, or nummular, or lenticular stones. These are round flattish bodies: but in general of a lenticular form, both sides possessing a slight degree of convexity. On each side are sometimes seen traces of its internal structure and of its spiral formation; whilst sometimes these appearances appear to be concealed by a thicker covering. Various opinions have been entertained respecting their origin, but no doubt can exist of their having existed in the ancient ocean as a spiral chambered shell, and of their being one of those species of animals which are now lost.

Among the fossil shells which can only be here enumerated, are the rare tuberculated turrilite, or chambered turbinated shell, the orbulites, planulites, and baculites, of Lamarck.

Insects of the smaller kinds are seldom found in a fossil state, the smallness of their size, and the delicacy of their structure, most probably preventing their preservation. Those which are in a state to allow any thing of their general form to be made out are consequently very few. The one which is generally found in the most perfect condition, is that which is generally known to us as the Dudley fossil, from its being found in the neighbourhood of Dudley, in Worcestershire. (Plate II. fig. 5.) Other species of this animal have been found in Wales, and in different parts of Germany. From the imperfect state in which these insects are found, little more, perhaps, can be said of them, except that the remains which have been examined, shew that the covering of their body was formed by three series of thick crustaceous plates, tranversely disposed in rows, the length of the body; whilst one plate served to give a covering to the head of the animal. Other remains of the smaller insects have been mentioned by different authors; but few or none appear to have been described as agreeing with any insect now known to be in existence.

The remains of lobsters and crabs are frequently found in the isle of Sheppey, and Malta. The remains of different species of these animals are also found in a compressed state in the margaceous and schistous masses of Pappenheim and Oppenheim.

The fossil remains of amphibia are very numerous, and supply us with ample exercise for inquiry and admiration. In different parts of England, particularly in Somersetshire and Dorsetshire, the remains of animals, apparently of the Lacerta genus, are frequently found; but are, as far as we are able to judge, really different from any animal which is known to us. But in no part of the world have such exquisitely fine and wonderful remains of animals of this description been found as in St. Peter's mountain near Maestricht. A most beautiful specimen of part of the jaw of the fossil animal of St. Peter's mountain was presented to the Royal Society, by professor Camper, and is now very properly exhibited in the British Museum. A wonderful specimen of the head of this animal has been also obtained from the same mountain by Faujas St. Fond; and is delineated in the elegant work which he has given to the world, descriptive of the fossil riches of that mountain. "Histoire Naturelle de la Montagne de Saint-Pierre de Maestricht."

The plates of St. Fond, as well as the specimen of professor Camper, shew that these are the remains, indubitably, of an enormous animal, different from any at present known. It must, however, be observed that the remains of crocodiles, apparently of the same species which now exist, have also been discovered: part of the head of the Asiatic crocodile was found in very good preservation in the quarries of Altdorff.

Fossil fishes have been found imbedded in calcareous and argillaceous masses, in various parts of Germany, Switzerland, and Italy; but no where in such prodigious numbers as in the mountain named Vestena-Nuova, generally called Monte Bolca, in the Veronese; which extends, in height, a thousand feet above the quarry, in which are found the numerous remains of fish; of which specimens are to be seen in almost every cabinet of repute in Europe.

The remains of fishes, from an inch to

upwards of three feet in length, are found in these quarries, and of these several are found whose living analogues are said to exist in the neighbourhood of Japan, and of Brazil, also in Africa and America. The Abbé Fortis is of opinion that the actual descendants of the Veronian fossil fishes are now to be found in the sea which washes the shores of Otaheite. In Cerigo, (Cytheria) Alessano, Lesina, in Dalmatia, Oeningen, Pappenheim, in Aix, and in several parts of France, fossil fishes are found in very excellent preservation. In England fossil fishes are much more rarely found than in France, Germany, or Italy.

The fossil fish of Vestena Nuova are supposed to prove, from several circumstances, that their privation of life was sudden; some having been found with the head of their prey still in their mouths; and others with the remains of the fish which they have devoured still in their stomachs.

The fossil remains of birds are very rarely found; although frequently mentioned, and even described by different authors. Fossils very much resembling the beaks of birds are sometimes found; but these are much more probably parts of fishes. Several of those specimens which have been spoken more positively of, as petrifactions of whole birds, and of their nests, have been merely calcareous incrustations of very modern formation. Bones very much resembling the bones of birds have been found in the calcareous stone of Oxfordshire, and in some parts of France, and of Germany.

The fossil remains of quadrupeds, especially those of the larger kind, are such as must necessarily excite the attention and wonder of every curious inquirer in natural history. In various parts of this country have been found the remains of elephants, and of other animals of considerable magnitude. In Ireland have been found the remains of deer of a size far exceeding any now known; and in Scotland have been found the remains of the elk, as well as those of an enormous animal of the ox kind, but larger than even the urus. In France, Germany, Italy, and indeed in most parts of Europe, remains of large animals have been found, and in both North and South America, the remains of enormous unknown animals have been discovered. According to Pallas, from the Tanais to the continental angle nearest to America, there is hardly a river in this immense space, especially in the plains, upon the shores, or in the bed of which, have not been found the bones of elephants and other animals, not of that climate. From the mountains by which Asia is bounded, to the frozen shores of the ocean, all Siberia is filled with prodigious bones; the best ivory (fossil) is found in the countries nearest to the arctic circle, as well as in the eastern countries, which are much colder than Europe, under the same latitude; countries where only the surface of the ground becomes thawed during summer.

The number of bones which have been discovered of the rhinoceros is very considerable, not only in Siberia, but in Germany, and in other parts of Europe: and in the opinion of St. Fond, founded not only on the discoveries of Pallas and others, but on his own observations made on the immense collection of Merck, joined with that of the Landgrave of Hesse Darmstadt, are of the species with double horns. An entire body of an animal of this species, still possessing the skin, fat, and muscles, has been dug up near the river Willioni, in the eastern parts of Siberia, from under a hill, which is covered with ice the greatest part of the year. St. Fond states, in confirmation of the above opinion, that another head obtained by Pallas from Siberia; one existing in the cabinet of the Elector of Manheim; and another in the cabinet of Merck, are all apparently similar to the head of the double horned rhinoceros of Africa.

This circumstance, so contradictory to the opinion he had formed, of these remains of large animals having been brought by floods from the eastern parts of the globe; and which opinion was confirmed by discovering that no remains of the African crocodile had been found in Europe; led him to further research, by which he found reason to suppose that, in fact, the rhinoceros, which corresponded with all the fossil remains which he had seen, was the rhinoceros of Sumatra. By ascertaining this circumstance, the difficulty was removed, since, Sumatra being separated from the peninsula of India merely by the Straits of Malacca, this animal might also have formerly existed there.

Much remains to be ascertained with respect to the fossil remains of elephants, of which considerable numbers have been found in various parts of England, France, Germany, and Italy; but no where so abundantly as in Siberia. In America indeed the remains of an unknown species of this animal are also very

abundant. There appears to be only two species of elephants now in existence; one (the Asiatic) being distinguished by its grinders being divided into transverse and nearly parallel plates, and the other (the African) having these plates disposed in lozenge-like forms.

The elephantine remains which have been found in Siberia, have been supposed to have belonged to no existing species; for though the teeth are formed of plates disposed parallel to each other, as in the Asiatic, these plates are said to be thinner, and consequently more numerous; but this distinction is by no means established. The remains of elephants discovered in this country seem referable, in most instances, to the Asiatic.

With respect to the elephant whose remains have been found in America, the tooth of which differs essentially from all known fossil or recent species, in having its crown cuspidated and covered with enamel, (Plate II. fig. 6) there exists at present every reason for supposing it to be of a species now extinct. The generally adopted opinion, that this animal was of a carnivorous nature, is by no means established; but is indeed contradicted by the assertion, that the stomach of one of these animals has been found filled with vegetable matter. One of these animals, with its flesh, skin, and hair, has been lately found in Siberia.

The remains of an animal, of an enormous size, has been found at Paraguay, at no great distance from the river Plata, which, being properly arranged, has been formed into a skeleton, and placed in the cabinet of natural history at Madrid. This animal, twelve feet in length and six in height, is distinguished, as well as by its general form, by the largeness of its claws; on which account, Mr. Jefferson, who has described some remains of a similar animal, in the Philosophical Transactions of Philadelphia, has named it the megalonyx. The celebrated Cuvier has arranged this animal with the sloths; but Faujas St. Fond, concluding that an animal so enormous was never intended to climb the trunks of trees, thinks he should not be thus classed; and wishes him to be held, as it were, in reserve, until some discoveries should supply us with more satisfactory notions respecting its nature.

In various parts of Scotland, and of France, in Tuscany, the Veronese, and in North America, have been found the fossil remains of some animal, which has been supposed to be a variety of the urus of Julius Cæsar, or of the bison. But these horns, which are of very considerable size, the bone of each horn exceeding two feet in length, appear to have belonged to a different species of animal from any which is at present known. The observations which have been made on these fossils, particularly by the liberal and industrious Faujas St. Fond, give great reason for believing that two species of animals have existed, bearing horns of this enormous magnitude. These remains are found to exist in Siberia along with the bones and horns of the rhinoceros, with the bones and teeth of the mammouthean elephant of Siberia.

To the fossil remains already mentioned, may be added the animal incognitum of Symore, in Languedoc; the enormous stag, found in the mosses of Ireland; the gigantic tapir, found at the bottom of the black mountains of Languedoc; the bears, of two species, now unknown, found in Bareith; and the numerous animals of unknown species which the admirably indefatigable Cuvier is perpetually discovering, in that mine of fossils, the quarries of gypsum, near Paris.

Of the mineralized remains of man no well attested instance is known. In a cavern, indeed, in Mendip Hills, some human bones have been found, invested with stalactite; these appear to be but comparatively of modern existence. Scheuchzer published an essay describing a supposed skeleton of a man; which was undoubtedly the remains of some large fish.

A view of the foregoing sketch cannot but shew, that the study of this science must prove a source of the highest gratification to every mind that contemplates the works of nature, for the purpose of obtaining a glimpse of the beauty which they display, and of the power which they manifest. By this science we obtain, not only a knowledge of the peculiar beings which dwelt on this planet in its antediluvian state, but we also acquire a more correct knowledge of the structure of this globe itself. We at the same time discover the strongest proofs of those changes which it has suffered, and which are recorded in the Holy Scriptures; whilst our reverential admiration is excited at this wonderful display of the power and providence of the Almighty creator.

ORYZA, in botany, *rice*, a genus of the Hexandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx glume

two-valved, one-flowered; corolla two-valved, almost equal, growing to the seed. There is but one species, with many varieties. Rice has the culm from one to six feet in length, annual, erect, simple, round, jointed; leaves subulate, linear, reflex, embracing, not fleshy; flowers in a terminating panicle; calycine leaflets, lanceolate; valves of the corolla equal in length; the inner valve even, awnless; the outer twice as wide, four-grooved, hispid, awned; style single, two-parted. Rice is cultivated in great abundance all over India, where the country will admit of being flooded, and in the southern provinces of China, Cochinchina, Cambodia, Siam, and Japan; in the latter place it is particularly white, and of the best quality.

OSBECKIA, in botany, so named in honour of Peter Osbeck, a genus of the Octandria Monogynia class and order. Natural order of Calycanthemæ. Melastomæ, Jussieu. Essential character: calyx four-cleft, with the lobes separated by a ciliary scale; corolla four-petalled; anthers beaked; capsule inferior, four-celled, surrounded by the truncated tube of the calyx. There are two species, *viz.* O. Chinensis, and O. Zeylanica.

OSCILLATION, in mechanics, the vibration, or reciprocal ascent and descent of a pendulum. See PENDULUM. It is demonstrated, that the time of a complete oscillation in a cycloid, is to the time in which a body would fall through the axis of that cycloid, as the circumference of a circle to its diameter; whence it follows: 1. That the oscillations in the cycloid are all performed in equal times, as being all in the same ratio to the time in which a body falls through the diameter of the generating circle. 2. As the middle part of the cycloid may be conceived to coincide with the generating circle, the time in a small arch of that circle will be nearly equal to the time in the cycloid: and hence the reason is evident, why the times in very little arches are equal. 3. The time of a complete oscillation in any little arch of a circle, is to the time in which a body would fall through half the radius, as the circumference of a circle to its diameter: that is, as 3.1416 to 1. If l denote the length of a pendulum, $g = 16\frac{1}{12} = 193$ inches, the space a heavy body falls through in the first second of time, and $p = 3.1416 =$ periphery of a circle whose diameter is 1, then, by the laws of falling bodies, it will be $\sqrt{g} : \sqrt{\frac{l}{2}} :: 1'' : \sqrt{\frac{l}{2g}} = \frac{4}{25}\sqrt{l} = \frac{16}{100}\sqrt{l}$ nearly the time of falling through $\frac{1}{2}l$: therefore $1 : p :: \sqrt{\frac{l}{2g}} = : p \sqrt{\frac{l}{2g}}$, which is the time of one vibration in any arch of the cycloid which has the diameter of its generating circle equal to $\frac{l}{2}$, l being the length of the pendulum in inches; and since the latter time is half the time in which a body would fall through the whole diameter, or any chord, it follows, that the time of an oscillation in any little arch, is to the time in which a body would fall through its chord, as the semicircle to the diameter. 4. The times of the oscillations in cycloids, or in small arches of circles, are in a sub-duplicate ratio of the lengths of the pendulums. 5. But if the bodies that oscillate be acted on by unequal accelerating forces, then the oscillation will be performed in times that are to one another in the ratio compounded of the direct sub-duplicate ratio of the lengths of the pendulums, and inverse sub-duplicate ratio of the accelerating forces. Hence it appears, that if oscillations of unequal pendulums are performed in the same time, the accelerating gravities of these pendulums must be as their lengths; and thus we conclude, that the force of gravity decreases as you go towards the equator, since we find, that the lengths of pendulums that vibrate seconds, are always less at a less distance from the equator. 6. The space described by a falling body in any given time, may be exactly known: for, finding by experiments what pendulum oscillates in that time, the half of the pendulum will be to the space required, in the duplicate ratio of the diameter of a circle to the circumference.

OSIER, a very valuable shrub, of the Salix viminales, used principally in basket making.

OSMITES, in botany, a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx imbricate, scariose; corolla of the ray ligulate; down obsolete; receptacle chaffy. There are four species, all shrubs, and natives of the Cape of Good Hope.

OSMIUM, one of the metals discovered by Mr. Tennant, in the black powder which remained after dissolving platina:

the other metal was IRIDIUM, which see. The osmium was obtained by heating the black powder with pure alkali in a silver crucible. The oxide of this metal combines with the alkali, may be expelled by an acid, and being very volatile, may be obtained by distillation. It does not redden vegetable blues, but stains the skin of a deep red or black. The oxide, in solution with water, has no colour; but by combining with alkali or lime, it becomes yellow. With the infusion of nut-galls, it gives a very vivid blue colour. It is precipitated by all the metals, excepting gold and platina. An amalgam may be formed with mercury, by agitating it with the aqueous solution of this oxide. When this amalgam is heated, the mercury is driven off, and the pure metal remains behind in the state of black powder. This metal was called osmium on account of the strong smell of the oxide.

OSMUNDA, in botany, a genus of the Cryptogamia Filices class and order. Natural order of Filices or Ferns. Generic character; capsules distinct, disposed in a raceme, in such a manner as to look the same way, or else heaped on the back of the pinna or division of the frond, sessile, sub-globular, opening transversely, without any ring: seeds very many, extremely minute. There are twenty-seven species.

OSSIFICATION, the formation of bones, but more particularly the conversion of parts naturally soft to the hardness and consistence of bones. All concretions which make their appearance in the solids of the animal body may be comprehended under this title with propriety, because they have a close resemblance to, and are composed of similar constituents with BONE, which see. In the pineal gland concretions have been found, which consist of phosphate of lime. The same is true of concretions found in the salivary glands, in the prostate, and in the liver; and also in pulmonary concretions. The latter however are found to contain phosphate and carbonate of lime, and in some cases no phosphate, but

Carbonate of lime	82
Animal matter and water	18
	100

OSTEOLOGY, that branch of anatomy which treats of the bones.

OSTEOSPERMUM, in botany, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ Jussieu. Essential character: calyx simple, or in two rows, many-leaved, almost equal; seeds globular, coloured, bony; down none; receptacle naked. There are seventeen species

OSTRACION, the *trunk fish*, in natural history, a genus of fishes, of the order Cartilaginei. Generic character: teeth cylindric, pointing forwards and rather blunt; body mailed by a complete long covering. There are twelve species. We shall notice only the O. triqueter, or the triangular trunk fish, is about twelve inches long, and is completely, except to a very short distance from the tail, surrounded with a bony covering, divided into hexagonal spaces, and overspread with a diaphanous epidermis, resembling thus the armadillo among quadrupeds. It is a native of the American and Indian seas, is thought a high delicacy in India, and lives, it is supposed, on worms and shell fish.

OSTREA, the *oyster*, in natural history, a genus of the Vermes Testacea class and order. Animal a tethys: shell bivalve, generally with unequal valves and slightly eared; hinge without teeth, but furnished with an ovate, hollow, and mostly lateral transverse grooves. About 150 species have been enumerated, and classed into sections and subsections. A. furnished with ears and radiate; scallop. B. rough, and generally plated on the outside; oysters. C. hinge with a perpendicular grooved line. Most of this genus are furnished at the hinge internally with numerous parallel transverse grooves in each valve, and are immediately distinguished from the genus arca, in not having teeth alternately locked in each other. Scallops leap out of the water to the distance of half a yard, and opening the shells, eject the water within them; after which they sink under the water, and suddenly close the shells with a loud snap. O. maxima: shell with about fourteen rounded and longitudinally striate rays; is found in most European seas, in large beds, whence they are dredged up, and pickled and barrelled for sale. This, we are told, is the shell which was formerly worn by pilgrims on the hat or coat, as a mark that they had crossed the sea, for the purpose of paying their devotions at the Holy Land; in commemoration of which it is still preserved in the arms of many families. O. edulis: shell nearly orbicular and rugged, with undulate imbricate scales; one valve flat and very entire. Of this species there are many va-

rieties. They inhabit European and Indian seas, affixed to rocks, or in large beds; the fish is well known as a palatable and nutritious food. The shell is of various sizes, forms, and colours; within white, and often glossy like mother of pearl; the old shells have often an anomia fixed to them, and are frequently covered with serpulæ, lepades, sertularia, and other marine productions. The following account has been given by Dr. Sprat of the treatment of oysters, in Great Britain.

In the month of May the oysters cast their spawn, (which the dredgers call their spats), it is like to a drop of a candle, and about the bigness of a halfpenny. The spat cleaves to stones, old oyster-shells, pieces of wood, and such like things, at the bottom of the sea, which they call cultch. It is probably conjectured, that the spat in twenty-four hours begins to have a shell. In the month of May, the dredgers (by the law of the Admiralty Court) have liberty to catch all manner of oysters, of what size soever. When they have taken them, with a knife they gently raise the small brood from the cultch, and then they throw the cultch in again, to preserve the ground for the future, unless they be so newly spat that they cannot be safely severed from the cultch; in that case they are permitted to take the stone, or shell, &c. that the spat is upon, one shell having many times twenty spats. After the month of May, it is a felony to carry away the cultch, and punishable to take any other oysters, unless it be those of that size (that is to say) about the bigness of a half-crown piece, or when, the two shells being shut, a fair shilling will rattle between them. The places where the oysters are chiefly catched, are called the Pont Burnham, Malden, and Colne Waters; the latter taking its name from the river of Colne, which passeth by Colne Chester, gives the name to that town, and runs into a creek of the sea at a place called the Hythe, being the suburbs of the town. This brood and other oysters they carry to creeks of the sea, at Brickel Sea, Mersey, Langno, Fingrego, Wivenho, Tolesbury, and Saltcoase, and there throw them into the channel, which they call their beds or layers, where they grow and fatten, and in two or three years the smallest brood will be oysters of the size aforesaid.

Those oysters which they would have green, they put into pits about three feet deep, in the salt marshes, which are overflowed only at spring tides, to which they have sluices, and let in the salt water until it is about a foot and a half deep. These pits, from some quality in the soil co-operating with the heat of the sun, will become green, and communicate their colour to the oysters that are put into them, in four or five days; though they commonly let them continue there six weeks or two months, in which time they will be of a dark green. To prove that the sun operates in the greening, Tolesbury pits will green only in summer; but that the earth hath the greater power, Brickel Sea pits green both winter and summer; and for a further proof, a pit within a foot of a greening pit will not green; and those that did green very well, will in time lose their quality.

The oysters, when the tide comes in, lie with their hollow shell downwards, and when it goes out they turn on the other side; they remove not from their place, unless in cold weather, to cover themselves in the ouse. The reason of the scarcity of oysters, and consequently of their dearness, is, because they are of late years bought up by the Dutch.

There are great penalties, by the Admiralty Court, laid upon those that fish out of those grounds which the court appoints, or that destroy the cultch, or that take any oysters that are not of size, or that do not tread under their feet, or throw upon the shore, a fish which they call a five-finger, resembling a spur-rowel, because that fish gets into the oysters when they gape, and sucks them out. The reason why such a penalty is set upon any that shall destroy the cultch is, because they find that, if that be taken away, the ouse will increase, and the muscles and cockles will breed there, and destroy the oysters, they having not whereon to stick their spat. The oysters are sick after they have spat; but in June and July they begin to mend, and in August they are perfectly well; the male oyster is black-sick, having a black substance in the fin; the female white-sick (as they term it) having a milky substance in the fin. They are salt in the pits, salter in the layers, but salter at sea.

O. Virginica. Shell nearly equi-valve, thick, rough and lamellous, one valve with a prominent beak, colour whitish or ochraceous, polished white within: length about 9 inches, breadth about 4 inches.

This is the shell emphatically called "oyster" in the markets of the different towns in the United States. The animal is in high esteem as a delicious and nu-

tritious food. Oysters are brought to the Philadelphia market principally from Egg-harbour and Delaware bay; the former are preferred for immediate use, having an agreeable sapid taste; the latter are generally dressed for the table, they have a thicker and rougher shell, and are fatter than those brought from Egg-harbour, or other parts of the coast, where the mixture of the fresh water is less abundant.

Those from the Delaware bay are known by the name of "fresh oysters," and the others by that of "salt oysters." They are merely varieties of the same species, notwithstanding their very different appearance and qualities.

OSTRICH. See Struthio.

OSYRIS, in botany, a genus of the Dioecia Triandria class and order. Natural order of Calycifloræ. Eleagnæ, Jussieu. Essential character: calyx trifid; corolla none: female, stigma roundish; drupe one-celled. There are two species, *viz.* O. alba, poet's casia, and O. japonica.

OTHERA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Berberides, Jussieu. Essential character: calyx four-parted; petals four, ovate, flat; stigma sessile; capsule. There is but one species, *viz.* O. japonica, which has a shrubby stem, with round, striated, purple branches; leaves alternate, ovate, blunt, coriaceous, spreading, an inch and half in length; petioles semicylindric, smooth; flowers axillary, aggregate, peduncled; it is a native of Japan.

OTHONNA, in botany, *African ragwort*, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx one-leafed, multifid, subcylindrical; down almost none; receptacle naked. There are twenty-seven species, among which we shall notice the O. bulbosa, bulbous African ragwort; this has a thick shrubby stalk, dividing into several branches, and rising five or six feet in height; the leaves come out in clusters from one point, spreading on every side; they are smooth, narrow at their base, enlarging gradually to their points, their edges are acutely indented like those of the holly; from the centre of their leaves arise the foot stalks of the flowers, being five or six inches long, branching out into several smaller, each sustaining one yellow radiated flower; these are succeeded by slender seeds crowned with down. Almost all the Othonnas are natives of the Cape of Good Hope.

OTIS, the *bustard*, in natural history, a genus of birds of the order Gallina. Generic character: bill somewhat convex; nostrils oval and open; tongue bifid and pointed; legs long, and naked above the knee; only three toes. Gmelin mentions eleven species, and Latham nine. We shall notice only the following: O. tarda, or the great bustard, is found in the plains of Europe, Asia, and Africa, but has never been observed in the New Continent. In England it is occasionally met with on Salisbury Plain, and in the wolds of Yorkshire, and formerly was not uncommonly seen in flocks of forty or fifty. It is the largest of British land birds, weighing often twenty-five or thirty pounds. It runs with great rapidity, so as to escape the pursuit of common dogs, but falls speedily a victim to the greyhound, which often overtakes it before it has power to commence its flight, the preparation for which, in this bird, is slow and laborious. The female lays her eggs on the bare ground, never more than two in number, in a hole scratched by her for the purpose; and if these are touched or soiled during her occasional absence, she immediately abandons them. The male is distinguished by a large pouch, beginning under the tongue, and reaching to the breast, capable of holding, according to Linnæus, seven quarts of water. This is sometimes useful to the female during incubation, and to the young before they quit their nest; and it has been observed to be eminently advantageous to the male bird himself, who on being attacked by birds of prey, has often discomfited his enemies by the sudden and violent discharge of water upon them. These birds are solitary and shy, and feed principally upon grasses, worms, and grain. They were formerly much hunted with dogs, and considered as supplying no uninteresting diversion. They swallow stones, pieces of metal, and other hard substances. Buffon states that one was opened by the academicians of France, which contained in its stomach ninety doubloons, and various stones, all highly smoothed by the attrition of the stomach. See Aves, Plate XI. fig. 1.

O. tetrax, or the little bustard, is met with in many parts of Europe, particularly in France, where it is taken by nets. It is rarely seen in England; is shy and cunning, if molested will fly about two hundred paces, and then run so fast that a man cannot overtake it. Its flesh is like

that of the great bustard, rich and delicate, and it would appear worth while to attempt the domestication of both these birds.

OTTER. See LUTRA.

OVAL, an oblong curvilinear figure, otherwise called ellipsis.

However, the proper oval, or egg-shape, differs considerably from that of the ellipsis, being an irregular figure, narrower at one end than at the other; whereas the ellipsis, or mathematical oval, is equally broad at each end, though it must be owned these two are commonly confounded together; even geometricians calling the oval a false ellipsis.

The method of describing an oval chiefly used by artificers is by a string, the length of which is equal to the greater diameter of the intended oval, and which is fastened by its extreme ends to two pins, placed in its longest diameter, then by holding it always stretched out with a pin or pencil carried round the inside, the oval is described, which will be longer or shorter, as the two fixed points are further apart.

OVIEDA, in botany, so named in honour of Gonsalvo Fernandez d'Oviedo, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Caprifolia, Jussieu. Essential character: calyx five-cleft; corolla tube subcylindric, superior, very long; berry globular, one-celled, quadripartile, four-seeded. There are two species, *viz.* O. spinosa, and O. mitis.

OVERSEERS *of the poor.* By 43 Elizabeth, c. 2, § 1, the churchwardens of every parish, or two substantial householders, to be nominated yearly in Easter week, or within one month after Easter, under the hand and seal of two justices of the peace of the county, shall be overseers of the same parish. In general all persons are liable to serve, with some exceptions as to peers of the realm, clergymen, parliament men, attornies, practising barristers, the president and members of the college of physicians, surgeons, and apothecaries free of the hall; dissenting ministers, prosecutors of felons, having a Tyburn ticket, and soldiers actually serving in the militia. In extensive parishes a greater number of overseers are appointed under 13 and 14 Charles II. c. 12, § 21; and by 17 Geo. II. c. 38, if an overseer dies, removes, or becomes insolvent, the justices may appoint another, and their appointment is subject to appeal to the sessions. By 43 Elizabeth, c. 2, § 2, overseers shall, within fourteen days after the appointment of new ones, deliver to them an account, to be allowed by two justices, and pay over balances due from them, which, if not paid, may be levied by distress, and the party committed to prison by the justices until the balance is paid, and the account delivered in; and by 17 George II. c. 38, the account is to be verified by oath. If he removes, the overseer is to account in like manner. If he dies, his executors have forty days to account, and must pay the balance before any other debts. Their duty consists in raising the poor's rate, taking care of the poor, giving relief to casual poor, and removing persons who come to settle in a tenement under 10*l.* a year, &c. without a certificate. They are also to bind out the children of poor persons, and in that case the infant parish apprentice and his master cannot vacate the indentures without the overseers. They also are to procure orders of maintenance of bastards to be made, and bonds to be taken from the reputed father to indemnify the parish. It has been usual for overseers in those cases, instead of taking a bond of indemnity, to accept of a sum of money, and discharge the father. But this has been lately held to be illegal, because it gives the overseers an interest to procure the death of the child. In cases of removal also overseers should be careful not to execute the order in a harsh or improper manner, for if a person die in consequence of a removal at a time of sickness, the overseer may be guilty of murder, and liable to an indictment. Overseers also should not improperly conspire to force persons who are with child of bastards to marry, and relieve the parish, for this also is indictable. By 17 George II. c. 38, if any person shall be aggrieved by any thing done or omitted by the churchwardens and overseers, or by any of his Majesty's justices of the peace, he may, giving reasonable notice to the churchwardens or overseers, appeal to the next general or quarter sessions, where the same shall be heard, or finally determined; but if reasonable notice be not given, then they shall adjourn the appeal to the next quarter sessions; and the court may award reasonable costs to either party, as they may do by 8 and 9th William, in case of appeals concerning settlements. See POOR. By 43 Elizabeth, c. 2, § 2, they forfeit 20*s.* on neglecting to meet in the vestry one Sunday in the month; and by 13 and 14 Charles II. c. 4, forfeit 5*l.* for refusing relief to a person duly removed by warrant

of two justices. By 9 George III. c. 37, § 7, they are to forfeit 10*s*. or 20*s*. for paying the poor in bad money.

OVERT *act*. In the case of treason, is compassing or imagining the death of the King; this imagining must be manifested by some open act; otherwise, being only an act of the mind, it cannot fall under any judicial cognizance. Bare words are held not to amount to an overt act, unless put into writing; in which case they are then held to be an overt act, as arguing a more deliberate intention. No evidence is to be admitted of any overt act, that is not expressly laid in the indictment, 7 Will. c. 3.

OVIPAROUS, a term applied to such animals as bring forth their young, *ab ovæ*, from eggs; as birds, insects, &c.

OVIS, the *sheep*, in natural history, a genus of mammalia of the order Pecora. Generic character: the horns hollow, wrinkled, turning backwards and outwards into a spiral form; lower front teeth eight; no canine teeth. There are nine species mentioned by Shaw. The following are most worthy of attention.

O. ammon, or the Siberian sheep, or the argali. The argali, or wild sheep, is the presumed origin of all the domestic sheep. It is found on the immense chain of mountains reaching through the middle of Asia to the Eastern Ocean. In Barbary, Corsica, Sardinia, Greece, and Kamtschatka, it is also to be met with, and in some of these places in great abundance. Its size is that of a fallow deer. In Siberia the argali is fond of ranging the highest elevations, and is generally seen in small flocks. As winter approaches, they move downwards into the plains, and instead of the shoots of the mountain plants, which were before their food, eat grass and other vegetables. They are extremely fond of salt, and will often remove the earth which covers this substance, in considerable quantities, in order to obtain it. Their horns grow to a vast size and weight. These animals are timid in a very great degree; but the males will occasionally engage in fierce conflicts with each other, and, it is said, endeavour to precipitate each other down the steeps of the mountains which they inhabit. They move over these rugged eminences with great agility, and the chase of them is difficult and fatiguing. They are supposed to live to the age of fourteen years.

O. aries, or the common sheep. This animal, in its state of complete domestication, appears equally stupid as it is harmless, and seems nearly to justify the observations of Buffon, who describes it as one of the most timid, imbecile, and contemptible of quadrupeds. When sheep, however, have an extensive range of pasture, and are left in a considerable degree to depend upon themselves for food and protection, they exhibit more respectability of character. A ram has been seen in these circumstances to attack and beat off a large and formidable dog, and even a bull has been felled by a stroke received between his eyes, as he was lowering his head to receive his adversary on his horns and toss him into the air. When individual efforts are unequal to the danger, sheep will unite their exertions; placing the females and their young in the middle of an irregular square, the rams will station themselves so as to present an armed front on every side to the enemy, and will support their ranks in the crisis of attack, harrassing the foe by the most formidable and sometimes fatal blows. Sheep display considerable sagacity in the selection of their food, and in the approach of storms they perceive the indications with accurate precision, and retire for shelter always to the spot which is best able to afford it. The domestic sheep is scarcely ever found (excepting in temperate latitudes) in a state approaching to perfection. In hot regions its wool degenerates into a species of hair, and in rigid climates, though the wool is fine at the roots, it is coarse towards the surface. The flesh of the animal, when it passes to great degrees, whether of heat or cold, appears also proportionably deteriorated. The wool of sheep in no country of the world attains greater excellence for the purposes of manufacture, without the assistance of any mixture, than in England. That of the Spanish breed is finer, but too short for manufacture by itself, and comparatively trifling in weight. Since England attained any considerable advance in civilization, its breed of sheep has been admired for the excellence of their fleeces, which constituted the grand material of national industry, wealth, and revenue. At present the worth of the wool annually shorn in that country is considerably upwards of two millions, and when wrought produces an amount of nearly seven millions sterling; facts which exhibit the importance of the cultivation of that animal, which is the source of all this opu-

lence, in a point of view particularly striking. There are several breeds or races in that country which have their respective admirers, and each of which will probably thrive better than others in certain soils and situations. The sheep of Lincolnshire afford the largest quantity of wool, but their flesh is more coarse and lean, and less pleasantly flavoured than that of some others. The sheep of the largest size are found in the rich district between Yorkshire and Durham, one of which was fed so highly as to weigh sixty-two pounds per quarter. These are reported to be equally prolific as they are large, and an ewe of this breed produced, at the age of two years, four young ones at a birth, and at the end of eleven months after, five more. The Dorsetshire breed is also considerably celebrated for fecundity; these are likewise highly admired for the delicacy and fine flavour of their flesh, but their wool is little in amount, though of excellent quality. In the North there is a hardy race of these animals, marked by their shaggy wool and black faces, which are admirably adapted to the bleak and mountainous tracts where they are produced, and sustain the rigour of winter in these cold situations without any inconvenience. Their eyes are wild, their movements nimble and rapid, and their flesh is peculiarly excellent. Towards the extreme points of the north of Scotland, there is a race of sheep particularly small, not exceeding six pounds per quarter in weight. The attention of noblemen and gentlemen of the first distinction has now long been directed to the cultivation of the sheep, with respect to every point of its economy, its breed, its food, and the nature and degree of those attentions which will best promote its excellence, both as an article for subsistence and manufacture. These efforts, not many years since, it must be acknowledged, took a somewhat singular direction, and it appeared to be the grand object of agricultural ingenuity, to raise the animal to that superlative degree of fatness which, in all but the most robust appetites, was calculated to excite disgust. In one instance, particularly, it was considered as an exploit of transcendent merit to have carried this process so far, that the fat of the animal, cut, without any slope, directly through the ribs, measured upwards of seven inches. This ludicrous, as well as pernicious and wasteful folly, has, however, now, for some years, ceased. The sheep is more subject to disorders than any of the domesticated animals; giddiness, consumption, scab, dropsy, and worms, frequently seizing upon and destroying it. The last are met with in vast numbers in the liver and gall bladder of these animals. These worms belong to the genus fasciola, are flat, oval, and pointed at the extremities. The fly is another formidable enemy, and is often fatal in the course of twenty-four hours, breeding within the skull of the animal. To extricate the sheep from this danger, the French shepherds apply the trephine without the slightest hesitation, and with the greatest dispatch and success. For the common ram, see Mammalia, Plate XVII. fig. 4.

The Cretan sheep is remarkable for long and large horns, twisted in the shape of a screw.

The many horned sheep is found most commonly in the north of Europe, and most frequently in Iceland. Three, four, and even five horns, are occasionally seen on these animals in considerably different forms, sizes, and situations. See Mammalia, Plate XVII. fig. 6.

The Cape sheep is remarkable for its emaciated appearance, long neck, and pendulous ears, and for having a pair of wattles under the neck like goats.

The broad-tailed sheep occurs in various countries of Asia and Africa, and is extremely similar to the European breed in almost all respects, but that its tail is of an immense weight, varying from fifteen to fifty pounds, under which the shepherds are reported to place a board with wheels, to facilitate the animal's movements. These tails are stated to constitute the most marrowy and luxurious food.

The Tibetian sheep yield wool of admirable length and fineness, and are said to produce the material from which are fabricated the Indian shawls, which are sometimes sold in this country for between thirty and fifty pounds.

O. montana. This species is remarkable for the fineness of its wool, being in this respect superior to any sheep hitherto known; and for the singular form of its horns, which are short, conical, slightly recurved, and acute at their tips. It is described in the Journal of the Academy of Natural Sciences of Philadelphia, Vol. 1. No. 1. by Mr. Geo. Ord. A portion of the skin, with the horn attached to it, is in Peale's Museum. It is a native of North America.

For a species of sheep called the dwarf sheep, see Mammalia, Plate XVII. fig. 5.

OUNCE, a little weight, the sixteenth part of a pound avoirdupois, and the twelfth part of a pound troy: the ounce avoirdupois is divided into eight drachms, and the ounce troy into twenty pennyweights. The avoirdupois ounce is less than the troy ounce, but the avoirdupois pound is greater than the troy pound. One hundred and seventy-five troy ounces are equal to one hundred and ninety-two avoirdupois ounces; but one hundred and forty-four pounds avoirdupois are equal to one hundred and seventy-five pounds troy. Therefore one pound avoirdupois, is equal to one pound, two ounces, eleven pennyweights, sixteen grains troy. See WEIGHT.

OVOLO, or OVUM, in architecture, a convex conic section, consisting of the elliptical, hyperbolical, or parabolical curves. It is generally used as a crowning member in the Grecian Doric, and when carved with the egg and dart, is termed Echinus.

OUSTED, in law, means put out, or removed, as ouster of possession as to lands.

OUTLAWRY, is being put out of the law, or out of the king's protection. It is a punishment inflicted for a contempt in refusing to be amenable to the process of the higher courts. By outlawry in civil actions, a person is so put out of the protection of the law, that he is not only incapable of suing for the redress of of injuries, but may be imprisoned, and forfeits all his goods and chattles, and the profits of his land; his personal chattels immediately upon the outlawry, and his chattels real and the profits of his lands when found by inquisition. Proceeding to outlawry is usually had in civil suits where an action is brought against two partners, and one is abroad; it is then necessary to outlaw him before the other can be proceeded against.

OUTWORKS, in fortification, all those works made without side the ditch of a fortified place, to cover and defend it. Outworks, called also advanced and detached works, are those which not only serve to cover the body of the place, but also to keep the enemy at a distance, and prevent his taking advantage of the cavities and elevations usually found in the places about the counterscarp, which might serve them either as lodgments, or as rideaux, to facilitate the carrying on their trenches, and planting their batteries against the place: such are ravelines, tenailles, horn-works, velopes, crown-works, &c. It is a general rule in all outworks, that if there be several of them, one before another, to cover one and the same tenaille of a place, the nearer ones must, gradually, one after another, command those that are further advanced out into the campaign, that is, must have higher ramparts, that so they may overlook and fire upon the beseigers when they are masters of the more outward works.

OWL. See STRIX.

OX. See BOS.

OXALIC *acid*, in chemistry, is found native in some acid vegetable juices, and rather plentifully in the "oxalis acetocella," or "wood-sorrel, and in other plants of the same genus; it is naturally united with a quantity of potash, not sufficient for complete saturation, forming what has been long known under the name of "Essential salt of sorrel." The oxalic acid is prepared artificially by boiling a sufficient quantity of nitric acid with a variety of vegetable and animal substances, such as sugar, mucilage, alcohol, animal jelly, &c. Take sugar as an example: one ounce in powder is put into a retort, with three ounces of strong nitric acid. During the solution, great quantities of the nitrous acid escapes: heat is to be applied till the nitrous gas is driven off. Three ounces more of nitric acid are to be added, and the boiling continued till the fumes cease, and the colour of the liquor vanishes. Pour out the liquor into a wide shallow vessel, and, when it cools, crystals will be formed, which may be collected and dried on unsized paper. The crystals thus obtained may again be dissolved in distilled water, and evaporated, to obtain new crystals. In this way oxalic acid may be obtained from the substances above enumerated, and many others, as alcohol, gum, honey, &c. Prepared in this way, oxalic acid is in a concrete state, crystallized in four-sided prisms, terminated in two sided summits. They are white and transparent, and have considerable lustre. They have a sharp taste, and change vegetable blues into a red colour, and produce the same effect on all vegetables, excepting indigo. The acid properties of this substance are so strong, that one part of concrete oxalic acid gives to 3,600 parts of water the property of reddening paper stained with turnsole. When exposed to heat it is volatilized, partly in a liquid, and also in a crystaline form. It cannot be decomposed but by a very great heat. It is deli-

quescent in moist air; and cold water dissolves about one-half its weight of the acid: boiling water dissolves a quantity equal to its own weight. This acid is decomposed by the sulphuric acid with heat, and charcoal is deposited: at the boiling temperature it is decomposed by the nitric acid, and converted into water and carbonic acid: its component parts are

Oxygen	77
Carbon	13
Hydrogen	10
	100

It combines with alkalies, earths, and metallic oxides, and the salts thus formed are denominated oxalates. The great attraction which this acid has for lime renders it of great utility in detecting that substance in every soluble combination.

OXALATES, in chemistry, salts formed of the oxalic acid and certain bases, are distinguished by the following properties: when exposed to a red heat, the acid is decomposed and driven off, and the base only remains. Lime water precipitates a white powder from their solutions, provided no excess of acid be present: the earthy oxalates are, in general, nearly insoluble in water, but they may be rendered soluble by an excess of the more powerful acids. See OXALIC *acid.*

OXALIS, in botany, *wood-sorrel,* a genus of the Decandria Pentagynia class and order. Natural order of Gruinales. Gerania, Jussieu. Essential character: calyx five parted; petals five, often connected at the base; capsule five-celled, five-cornered, opening at the corners; seeds arilled. There are ninety-six species, of which the O. acetosella, common wood-sorrel, has a perennial, branched, knobbed, creeping root, having fine fibrils on every side, partly red and partly white, with an ovate, acute, rigid scale, like a tooth, at the knobs; scapes one or two, jointed at the base, the length of the leaves; calycine leaflets, oblong, acute, sometimes bifid, ciliate, purple at the tip, upright. Linnæus remarks, that the leaflets in wet weather are erected, but hang down in dry weather. It has been observed, that this elegant little plant has the leaves of trefoil, the taste of sorrel, and the flower of geranium; from which last genus this is distinct, in the number of styles, the form of the capsule and manner of its opening, its straight corcle, or heart, without any perisperm or albumen: it is common all over Europe.

OXGANG, or OXGATE, is generally taken, in our old law books, for fifteen acres, or as much ground as a single ox can plow in a year.

OXIDE, in chemistry. Metallic substances are not only of vast importance in the arts of civilized life, on account of the properties which belong to them in the metallic state; but many of them are not less valuable in those changes which they undergo by new combinations, and the new properties they acquire, in consequence of these changes. One of the first and most ordinary changes to which metallic substances are subject, is their combination with oxygen. This is called, in chemical language, oxydation. If a metal, as for instance, a piece of iron, is exposed to the air, when it is moist, it soon undergoes a remarkable change. It loses its metallic lustre, and the surface is covered with a brownish powder, well known by the name of rust. This change is owing to the combination of oxygen with the metal, and the rust of the metal in this state is known in chemistry by the name of oxide. The process by which this compound of oxygen and a metallic substance is formed, is called oxydation, and the product is denominated an oxide. The process of oxydation is effected more rapidly when metals are exposed to the action of heat; and, indeed, many metals require a very high temperature to produce the combination, while it cannot be accomplished in others by the greatest degree of heat that can be produced. This process was formerly called calcination, or calcining the metal; and the product now denominated an oxide, was distinguished by the name of calx or calces, from its being reduced to the state of powder, in the same way as limestone, by burning. Metals differ very much from each other in the circumstances in which this oxydation takes place, as in the temperature which is necessary, the facility of the combination, the proportions of oxygen which combine, and the force of affinity between the constituent parts of the oxide. Some metals are oxydated in the lowest temperature, as, for instance, iron and manganese; while others require the greatest degree of heat that can be applied. Such are silver, gold, and platina.

The facility with which oxydation takes place in some metals is so great, such as in iron, tin, lead, copper, and manganese, that they must be completely defended

from the action of oxygen; but in gold and platina, no perceptible change is observed, for whatever length of time they are exposed to the atmosphere. This oxydation, and the quantity of oxygen absorbed, is proportionable to the temperature. There are, however, many metals which combine with a determinate proportion of oxygen at certain temperatures, and from this may be estimated the quantity of oxydation from the degree of heat which has been applied. The rapidity of the oxydation is almost always increased by the elevation of temperature. In this way actual combustion or inflammation is produced. Thus filings of metals thrown upon a body in a state of ignition, give out brilliant sparks; and steel, struck upon a flint, burns with a vivid flame in the air, in consequence of the great heat which is communicated to it by percussion. Metallic substances combine with very different proportions of oxygen; and this quantity varies according to the manner in which the process has been conducted, or the temperature to which the metal has been exposed.

In these different states and conditions of oxydation different phenomena are exhibited. Sometimes the metal becomes red hot, and is inflamed; sometimes the oxygen takes place without fusion, or does not combine with oxygen till after it has been melted; sometimes it is covered with a brittle crust, or with a substance in the form of powder. At other times a pelicle, exhibiting different colours, forms on the surface: but, in all cases, the metal is tarnished, loses its brilliancy and its colour, and assumes another, which announces the change that has taken place. Another difference which takes place among metals, is the different degrees of force with which the oxygen adheres to the metal. The knowledge of this, and the different degrees of affinity between oxygen and metallic substances, is of great importance in many operations and chemical results. During the fixation of oxygen in metallic substances, it is absorbed by some in its solid state, and gives out a great deal of caloric. In others it is combined, without giving out the same quantity. This proportion of caloric given out corresponds to the facility with which oxides part with their oxygen, or are reduced to the metallic state. Those which have combined with oxygen, with the greater proportion of caloric, are most easily reduced; but those, on the contrary, in which the oxygen has been deprived of its caloric, are reduced to the metallic state by a great addition of caloric, and the greatest number of oxides require the addition of substances, whose affinity for oxygen is greater than that of the metal. Metallic oxides are extremely different in different metals, and even in the same metal, according to the proportion of oxygen. They are, however, possessed of some common properties. They are all in the form of powder or earthy substance, or so brittle as to be easily reduced to this state. They exhibit every shade of colour, from pure white to brown and deep red, and they are heavier than the metals from which they have been obtained. Some oxides are revived, as it is called, or are reduced to the metallic state, merely by being in contact with light or caloric. Some require the addition of a combustible substance and a high temperature; while others have so strong an affinity for oxygen, that they cannot be deprived of it by the strongest heat, but become fusible in the fire, and afford a glassy matter more or less coloured, and even serve as a flux to the earths. Some oxides are volatile, but the greatest number are fixed. Some have an acrid and caustic taste, are more or less soluble in in water, and even possess an acid quality; others are insoluble and insipid.

OXOPHYLLUM, in botany, a genus of the Monadelphia Pentandria class and order. Natural order of Trihilatæ. Meliæ, Jussieu. Essential character; one-styled; calyx five toothed; petals five, long; filaments sheathing the style, five-toothed at top; teeth antheriferous; stigma one; capsule five-celled. There is but one species, *viz.* O. fœtidum; this is a shrub about ten feet in height, and nearly six inches in diameter; the bark is green and smooth, the wood white, tender, and fragile; the branches twiggy, garnished with alternate leaves, each leaf digitated, having three large lobes growing on a foot-stalk of five or six inches in length; each lobe is divided by a longitudinal nerve, which is prominent beneath; the flowers spring from the bottoms of the leaves, at the extremity of the twigs and branches; their common foot-stalk is about a foot in height, dividing at its summit into several smaller ones, on each of which are placed alternate sessile flowers; the corolla is white, each petal being an inch long, and, as it were, glued to each other, longitudinally, by their borders, so as to form a kind of tubular figure, the upper part spreading; these

petals cover a white membranaceous tube, which on its upper part divides into five short filaments, supporting at their points the anthers. This shrub is a native of the forests of Guiana, flowering in February.

OXYDATION, } sometimes spelt
OXYGENATION, } OXIDATION, &c. See OXIDE. See also Murray's "Chemistry," vol. ii. for the proper use of the several terms.

OXYDIZEMENT, } terms used by
OXYGENIZE, } some authors for OXYDATION, OXYGENATION, &c. which see.

OXYGEN, in chemistry, is one of the most important agents in nature; there is scarcely a single process, either natural or artificial, in which oxygen has not a share, but it is known only in combination with other bodies. "Oxygen," says Mr. Murray, "denotes the solid base or gravitating matter, and oxygen gas is the name given to it, when it exists in the ærial form." There are two vast sources whence oxygen is derived, *viz.* water and air; in the former it is condensed into the liquid form, and combined with about one-third of its weight of hydrogen; in the latter it is united with an azote, and forms about one-fifth of the atmosphere. Besides these, there are a multitude of other sources, such as many parts of the organized world, vegetable or animal, mineral acids and metallic oxides Oxygen has a greater tendency to combination, than any other chemical agent. It is necessary to support combustion and during the process it combines with the combustible body. The products are compounds of oxygen, and are both numerous and important agents in chemistry. The acids are of this kind, and their activity is principally dependent on their oxygen, which they yield readily to other bodies, and which, by the dense state in which it exists, is often capable of exerting powerful affinities. All the metals, likewise, are capable of combining with this principle, from which a number of compounds are formed. See GAS, *oxygen.*

OXYGENATED *muriatic acid,* in chemistry, is prepared in the following manner; take equal parts of the oxide of manganese, and the red oxide of mercury or lead; put them into a glass retort, and add four parts of concentrated muriatic acid. This, on distillation, affords a quantity of yellow aeriform fluid, which is oxygenated muriatic gas; this being agitated with water combines with it, and forms oxygenated muriatic acid. The gas is yellow and transparent, and possesses a most suffocating smell. It instantly extinguishes flame and animal life; but has been long used for bleaching.

OXYGONE, in geometry, is an acute angled figure, or such, each of the angles of which is less than 90°. The term is chiefly applied to triangles, where the angles are all acute.

OYER *of a deed,* in law, is when a man brings an action upon a deed, bond, &c. and the defendant appears and prays that he may hear the bond, &c. wherewith he is charged; and the same shall be allowed him. And he is not bound to plead till he has it, paying for the copy of the instrument. It is then set forth upon the pleadings.

OYER and TERMINER, in law, is a court, by virtue of the King's commission, to hear and determine all treasons, felonies, and misdemeanors. This commission is usually directed to two of the judges of the circuit, and several gentlemen of the county; but the judges only are of the quorum, so that the rest cannot act without them.

OYER *of the records,* in law, is a petition made in court, that the judges, for more satisfactory proof, will be pleased to hear or look upon any record.

O YES, corrupted from the French *oyez,* hear ye, is an expression used by the crier of a court, in order to enjoin silence, when any proclamation is made.

OYSTER. See OSTREA.

OZANAM (JAMES), in biography, an eminent French mathematician, was descended from a family of Jewish extraction, but which had long been converts to the Romish faith; and some of whom had considerable places in the parliament of Provence. He was born at Boligneaux, in Bressia, in the year 1640; and being a younger son, though his father had a good estate, it was thought proper to breed him to the church, that he might enjoy some small benefices which belonged to the family, to serve as a provision for him. Accordingly he studied divinity four years; but then, on the death of his father, he devoted himself entirely to the mathematics, to which he had always been strongly attached. Some mathematical books which fell into his hands first excited his curiosity; and by his extraordinary genius, without the aid of a master, he made so great a progress, that at the age of fifteen he wrote a treatise of that kind.

For a maintenance, he first went to

Lyons to teach the mathematics, which answered very well there; and after some time his generous disposition procured him still better success elsewhere. Among his scholars were two foreigners, who expressing their uneasiness to him at being disappointed of some bills of exchange for a journey to Paris, he asked them how much would do, and being told fifty pistoles, he lent them the money immediately, even without their note for it. Upon their arrival at Paris, mentioning this generous action to M. Daguesseau, father of the chancellor, this magistrate was touched with it, and engaged them to invite Ozanam to Paris, with a promise of his favour. The opportunity was eagerly embraced; and the business of teaching the mathematics here soon brought him in a considerable income; but he wanted prudence for some time to make the best use of it. He was young, handsome, and sprightly; and much addicted both to gaming and gallantry, which continually drained his purse. Among others, he had a love intrigue with a woman who lodged in the same house with himself, and gave herself out for a person of condition. However, this expense, in time, led him to think of matrimony, and he soon after married a young woman without fortune. She made amends for this defect, by her modesty, virtue, and sweet temper; so that, though the state of his purse was not amended, yet he had more home-felt enjoyment than before, being indeed completely happy in her as long as she lived. He had twelve children by her, who mostly all died young; and he was lastly rendered quite unhappy by the death of his wife also, which happened in 1701. Neither did this misfortune come singly; for the war breaking out about the same time, on account of the Spanish succession, it swept away all his scholars, who being foreigners, were obliged to leave Paris. Thus he sunk into a melancholy state; under which, however, he received some relief and amusement from the honour of being admitted this same year an *eleve* of the Royal Academy of Sciences.

He seems to have had a presentiment of his death from some lurking disorder within, of which no outward symptom appeared. In that persuasion he refused to engage with some foreign noblemen, who offered to become his scholars, alleging that he should not live long enough to carry them through their intended course. Accordingly he was seized soon after with an apoplexy, which terminated his existence in less than two hours, on the third of April, 1717, at 77 years of age.

Ozanam was of a mild and calm disposition, a cheerful and pleasant temper, endeared by a generosity almost unparalleled. His manners were irreproachable after marriage; and he was sincerely pious and zealously devout, though studiously avoiding to meddle in theological questions. He used to say, that it was the business of the Sorbonne to discuss, of the Pope to decide, and of a mathematician to go straight to heaven in a perpendicular line. He wrote a great number of useful books.

P.

P, Or *p*, the fifteenth letter, and eleventh consonant of the alphabet; the sound of which is formed by expressing the breath somewhat more suddenly than in forming the sound of *b*: in other respects, these two sounds are very much alike, and are often confounded one with another. When *p* stands before *t* or *s*, its sound is lost, as in the words *psalms*, *Ptolemaic*, *ptisan*, &c. when placed before *h*, they both together have the sound of *f*, as in *philosophy*, *physic*, &c.

In the Italian music, P. stands for piano, or softly; P P. for piu piano, *i. e.* more softly; and P P P. for pianissimo, or very softly.

Among astronomers, P. M. is used to denote post meridian, or afternoon; and sometimes for post mane, *i. e.* after midnight.

As a numeral, P. signifies the same as G. *viz.* 400; and with a dash over it, thus $\overline{P}$, 400,000.

Among physicians, P. denotes pugil, or the eighth part of an handful; P. Æ. partes æquales, or equal parts of the ingredients; P. P. signifies pulvis patrum, *i. e.* the Jesuits-powder; and ppt. præparatus, prepared.

PACE, a measure taken from the space between the two feet of a man, in walking; usually reckoned two feet and an half, and in some men a yard or three feet. See MEASURE.

The geometrical pace is five feet; and 60,000 such paces make one degree of the equator.

PACKERS, persons whose employment it is to pack up all goods intended for exportation; which they do for the great trading companies and merchants of London, and are answerable if the goods receive any damage through bad package.

PACO, a species of the Camelus, found in Peru.

PÆDERIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ. Rubiaceæ, Jussieu. Essential character: contorted; berry void, brittle, two-seeded; style bifid. There are two species, *viz.* P. fœtida, and P. fragrans, the former is a native of the East Indies, and the latter of the island of Mauritius.

PÆDEROTA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Personatæ. Scrophulariæ, Jussieu. Essential character: corolla four-cleft; calyx five-parted; capsule two-celled. There are three species.

PÆONIA, in botany, *peony*, a genus of the Polyandria Digynia class and order. Natural order of Multisiliquæ. Ranunculaceæ, Jussieu. Essential character: calyx five-leaved; petals five; styles none; capsule many-seeded. There are five species, of which P. albiflora, white-flowered peony, has the root composed of a few cylindrical or fusiform tubers, united at top; stem, from a radical leafless sheath, two feet in height, slender, round; leaves alternate on long petioles; leaflets three-parted; the whole plant is very smooth and shining; the calyx is raised above the floral leaf on a short thick peduncle; petals eight, very large, milk white, oval, concave, stamens about one hundred and fifty, with the filaments as well as anthers yellow; within the stamens is a fungose, subcontinuous, lobed crown, more slender than in its congeners; the germs are smooth, conical, purple at the tip; stigma compressed into a comb or crest, suborbicular, hooked; seeds, when ripe, of a yellowish testaceous colour. It is a native of Siberia; it is well known among the Daurians and Mongols on account of the root, which they boil in their broth; the seeds they grind to put into their tea.

PAGANISM, the religion of the Heathen nations, in which the Deity is represented under various forms, and by all kinds of images or idols; it is therefore called idolatry, or image worship. The theology of the Pagans was of three sorts, *viz.* fabulous, natural, and political or civil. The first treats of the genealogy, worship, and attributes of their deities; who were, for the most part, the offspring of the imagination of poets, painters, and statuaries. To their gods were given different names, and opposite attributes, ascribing to them every species of vice, as well as to some of them every virtue. There is, however, in the delightful fictions of Homer and Hesiod, much that is entertaining, curious, and even useful. The flowers of the garden and the field, whose beauties we so much admire, were once thought to be produced by the tears of Aurora, the goddess of the morning, whose rose-coloured fingers open the gates of the east, pour the dew upon the earth, and make the flowers grow. When the leaves were agitated, or the long grass of the meadows performed its graceful undulations, all was put in motion by the breath of Zephyrus, the god of the west-wind. The murmurs of the waters were the sighs of the Naïades, little deities who presided over rivers, springs, wells, and fountains. A god impels the wind; a god pours out the rivers; grapes are the gift of Bacchus; Ceres presides over the harvest; orchards are the care of Pomona. Does a shepherd sound his reed on the summit of a mountain, it is Pan, who, with his pastoral pipe, returns the amorous lay. When the sportsman's horn rouses the attentive ear, it is Diana, armed with her bow and quiver, and more nimble than the stag that she pursues, who takes the diversion of the chace. The sun is a god, riding on a car of fire, diffusing his light through the world; the stars are so many divinities, who measure with their beams the regular progress of fire; the moon presides over the silence of the night, and consoles the world for the absence of her brother. Neptune reigns in the sea, surrounded

by the Nereides, who dance to the joyous shells of the Tritons. In the highest heaven is seated Jupiter, the master and father of men and gods. Under his feet roll the thunders, forged by the Cyclops in the caverns of Etna; his smile rejoices nature, and his nod shakes the foundation of Olympus. Surrounding the throne of their Sovereign, the other divinities quaff nectar from a cup, presented them by the young and beautiful Hebe. In the middle of the great circle shines, with distinguished lustre, the unrivalled beauty of Venus, alone adorned with a splendid girdle, in which the graces and sports for ever play; and in her hand is a smiling boy, whose power is universally acknowledged by heaven and earth. Music, poetry, dancing, and the liberal arts, are all inspired by one or other of the nine muses; while the votaries of martial glory derive their courage and success from Mars, the god of battles. Such is a general outline of the pleasing and inoffensive part of the fabulous theology of the Pagan world. On the other hand, as we have already intimated, many of the gods of the ancients possessed attributes at once disgraceful to, and unworthy of deity, and hurtful to the interests of morality and human happiness. Jupiter himself set an example of lust; and Bacchus was worshipped with cruel and obscene revellings.

Many, however, of the heathen writers condemned this part of their theology; among which are Sanchoniatho, the Phœnician; and among the Greeks, Orpheus, Hesiod, and Pherecyde.

The natural theology of the Pagans was studied and taught by the philosophers, who rejected the multiplicity of gods introduced by the poets, and brought their theology to a more rational form. Some of them seem to have possessed considerable knowledge respecting the unity of the Supreme Deity: yet even Socrates, the best man and wisest of the philosophers of the Pagan world, so far yielded to the prejudices and practices of the age in which he lived, as to order his friends, just before his death, to sacrifice a cock to Esculapius, the god of physic.

The political or civil theology of the Pagans was instituted by legislators, statesmen, and politicians. This chiefly respected their temples, altars, sacrifices, and rites of worship, and was properly their idolatry; the care of which belonged to the priests, who were servants of the state. These ceremonies, &c. were enjoined the commonality, to keep them in subjection to the civil power. Such was the religion of the greater part of the world before the promulgation of Christianity; and such still, in some form or other, is the religion of those parts of the world, containing a population of about 420 millions of souls; or above one half of the inhabitants of the whole earth, where the gospel is not preached, either in its purity, or as corrupted by the doctrines of Mahomet. The Missionaries employed for the conversion of the heathen, though very zealous and very numerous, have hitherto made comparatively little progress. The Foreign and British Bible Society may possibly have some beneficial effects in enlightening the darkness of the pagan world; but, we are persuaded, nothing but conquest and civilization, short of miracle itself, will ever prove effectual in the extirpation of heathenism, and the final establishment of Christianity.

PAGE, a youth of state retained in the family of a prince or great personage, as an honourable servant, to attend in visits of ceremony, do messages, bear up trains, robes, &c. and at the same time to have a genteel education, and learn his exercises. The pages in the King's household are various, and have various offices assigned them, as pages of honour, pages of the presence chamber, pages of the back stairs, &c.

PAGEANT, a triumphal car, chariot, arch, or other like pompous decoration, variously adorned with colours, flags, &c. carried about in public shews, processions, &c.

PAGOD, or PAGODA, a name whereby the East Indians call the temple in which they worship their gods. Before they build a pagod, they consecrate the ground as follows: after having inclosed it with boards or palisadoes, when the grass is grown on the ground they turn an ash coloured cow into it, who stays there a whole day and night; and as cow-dung is thought by the Indians to be of a very sacred nature, they search for this sacred deposit, and having found it, they dig there a deep pit, into which they put a marble-pillar, rising considerably above the surface of the earth. On this pillar they place the image of the god to whom the pagod is to be consecrated. After this the pagod is built round the pit, in which the pillar is fixed. The pagod usually consists of three parts, the first is a vaulted roof supported on stone or marble columns. It is adorned with images, and, being open, all persons without dis-

tinction are allowed to enter it: the second part is filled with grotesque and monstrous figures, and no body is allowed to enter it but the bramins themselves: the third is a kind of chancel, in which the statue of the deity is placed: it is shut up with a very strong gate. This word is sometimes used for the idol, as well as for the temple.

Pagod, or Pagoda, is also the name of a gold and silver coin, current in several parts of the East Indies.

PAIN, is defined to be an uneasy sensation arising from a sudden and violent solution of the continuity, or some other accident in the nerves, membranes, vessels, muscles, &c. of the body; or, according to some, in consists in a motion of the organs of sense; and according to others, it is an emotion of the soul occasioned by these organs.

PAINTING. The art of painting may not improperly be defined, a mode of conveying ideas to the mind by means of a representation of the visible parts of nature. It is a language by which, though all things cannot, many at least may be expressed, in a stronger and clearer manner than can be effected by any other; nay, it is, to its extent, a universal language; though it is only in proportion as we are accustomed to read it that we can hope to acquire ideas through its means.

The particular education of our senses or organs is uudoubtedly the only mode by which those senses can be rendered serviceable to us in their full extent; for although, in their natural and uncultivated state, they are enabled to present us with tolerably clear and distinct ideas of things of a simple kind, or which differ considerably from each other; it is far otherwise when we expect from them just ideas of things complicated, or of such as differ from each other by small, nay almost imperceptible gradations. The untutored eye readily distinguishes black from white, red from blue, and purple from green; but is unable to detect the delicate transitions from one shade to another of the same colour, and still less the nicer variations of combined and complex colours.

The quickest of all operations is perhaps that of sight, and in one moment we are enabled to see many objects; but we cannot, as Leonardo da Vinci properly observes, distinguish and understand clearly more than one at a time. Upon the first sight of a page of a written or a printed book, though we observe it to be full of words, we do not discover the sense contained. No! to understand, we are obliged to read it; and in case the subject be abtruse, and our comprehensions dull, it may be necessary to peruse it two or three times before the whole sense be clearly understood by us; some there may be who never will comprehend it. The situation of that man who, from long habit, reads with facility and quickness, is likewise far removed from that of the beginner, who having little practice, can only read slowly and with difficulty.

We have judged it necessary to premise these few observations, in hopes to correct a mistaken but prevalent notion, that although a thorough conversance with painting is required ere a person be adequate to decide discreetly as to the executive parts of a work of art, to distinguish the copy from the original, or the pencils of the different masters; every man is intuitively enabled to enjoy the effect of the whole, to enter into the expression and feeling of the piece, and, in short, to judge rightly between a bad picture and a good one. Nay, a moment is sufficient for one of these self-dubbed critics to pass an irrevocable sentence on the most extensive and studied composition.

In treating the subject before us, we shall not by a slow and tedious process attempt to conduct the student of painting through the long and rugged path by which alone even a moderate degree of excellence may be attained; this would be like commencing a treatise on rhetoric with the minutiæ of orthography and grammar. We shall rather, by a short inquiry into the fundamental principles of the art, and a reference to the example of the greatest masters, draw his attention to the proper application of that mechanical skill of which we suppose him already possessed.

Invention, composition, design, expression, chiara obscura, and colouring, may perhaps not improperly be termed the great component parts of painting, unless indeed it be insisted that invention is rather the parent and director of the others to the proper objects of their attainment.

We have defined painting to be a mode of communicating ideas to the mind, by means of a representation of the visible parts of nature; and we have adopted this mode of expression, because the art can hardly be said to be confined to the mere representation of visible objects,

since by delineating outward demonstrations it is enabled to convey the ideas of internal affections and mental actions. It will necessarily follow that those subjects are the most immediately within the province of our art, whose essential qualities are as it were contained in the visible parts of things, or most capable of being expressed by objects of sight; and this, though a truism, we have thought it necessary to state, as experience every day shews, that it is not sufficiently attended to. By the essential qualities of a subject, we must be understood to mean those which give it its interest.

The only means by which the painter can communicate his ideas to the spectator, or in other words, tell his story, are combinations of figures and other visible objects, the representation of gesture, and the expression of countenance.

As the powers of writing, in the way of narrative, are such as to enable it to convey to the reader a just idea of a succession of transactions or events; whereas it cannot by the most laboured description give us any other than a confused or erroneous notion of the situation of a building, the windings of a river, the forms of a mountain, or the beauty and expression of a countenance; so painting, inasmuch as it is incompetent to relate the conspiracy, or record the oration, is proportionably rich in its means of description. As description is the most arduous task of language, so narration is the great difficulty of painting; a difficulty however not always insurmountable to the artist, who, to a competent knowledge and practice in the several component parts of his art, adds that of judgment in the choice of his subject, as will presently appear.

In a picture, the artist must necessarily choose one point of time for his representation; but the usual doctrine, that a picture can absolutely express no more than this one moment of the story, requires some illustration, as otherwise the inconsiderate might naturally be led to underrate the powers of communication given to our art. The truth we believe is, that though a picture must represent one moment of time, only, yet in that representation, the memorial, as it were, of past moments may be recorded, and the idea of future ones clearly anticipated; and though this doctrine may, upon first sight, appear opposed to generally established opinion, a little reflection will, we are assured, convince any one of its truth.

It will require very little argument to shew, that many of the bodily actions of men do indicate, and, under particular circumstances, demonstrate certain other actions to have taken place previously; which is certainly expressing the past in the present; nor will it be more difficult to find instances of a present action denoting some future one; that is, expressing the future in the present. A figure walking, or running, denotes a past, a present, and a future action. The sword of the soldier drawn and lifted up over the neck of the beautiful St. Catharine, denotes a future act or event; that of her head being severed from her body; the hardened executioner forcing his sword into the scabbard, after having performed his office, as clearly shews what has gone before.

Two things should concur to render a story eminently eligible for painting. First, the incident or act to be represented should be of an unequivocal nature; such as, when represented, can leave no doubt on the mind of the observer as to its meaning; and secondly, either the cause of the act, or its probable consequence, or result, should be such as is capable of being expressed by objects in the picture; but when both the cause or the end proposed in the act represented, and the consequence of that act, can be made evident to us in a picture, such a picture is a narration, becomes truly a dumb poesy, and creates a most lively interest in our minds, possessing, as it does, those properties which, as Aristotle observes, are necessary to the perfection of a drama; a beginning, a middle, and an end.

When we behold a representation of the Corinthian maid tracing the shadow of her favoured youth on the wall, love, the cause of the action, is rendered apparent by the endearments attending it: the consequence, which we are told was the invention of painting, is not evident to one uninformed of the tradition. Not so in Mr. Fuseli's pathetic composition of Paolo and Francesca, from Dante. Here we are at a loss as to no one of these particulars; the picture in every respect explaining itself with as much force, and as unequivocally, as the poem. Love urges the stolen kiss and guilty dalliance, and the consequence is as evidently the destruction of the lovers by the avenging and uplifted hand of the insulted husband.

PAINTING.

Invention, in painting, consists principally in three things: first, the choice of a subject properly within the scope of the art; secondly, the seizure of the most striking and energetic moment of time for representation; and lastly, the discovery and selection of such objects, and such probable incidental circumstances, as, combined together, may best tend to develope the story, or augment the interest of the piece. The cartoons of Raffaele, at Hampton Court, furnish us with an example of genius and sagacity in this part of the art, too much to our present purpose to be omitted. We shall describe it in the words of Mr. Webbe. "When the inhabitants of Lystra are about to offer sacrifice to Paul and Barnabas, it was necessary to let us into the cause of all the motion and hurry before us; accordingly, the cripple, whom they had miraculously healed, appears in the crowd: observe the means which the painter has used to distinguish this object, and of course to open the subject of his piece. His crutches, now useless, are thrown to the ground; his attitude is that of one accustomed to such a support, and still doubtful of his limbs; the eagerness, the impetuosity, with which he solicits his benefactors to accept the honours destined for them, point out his gratitude, and the occasion of it: during the time that he is thus busied, an elderly citizen, of some consequence, by his appearance, draws near, and lifting up the corner of his vest, surveys with astonishment the limb newly restored; whilst a man of middle age, and a youth, looking over the shoulder of the cripple, are intent on the same object. The wit of man could not devise means more certain of the end proposed; such a chain of circumstances is equal to a narration; and I cannot but think, that the whole would have been an example of invention and conduct, even in the happiest age of antiquity." The works of the first restorers of painting may be likewise studied with great profit, so far as relates to invention, composition, and expression. In the executive parts of the art they seldom approach even mediocrity: less able therefore to gratify the eye, the artist applied himself exclusively to interest the mind of the spectator. Amongst the frescoes of Giotto, in the church of St. Francis, at Assisi, is one which, from the ingenuity of its invention, seems particularly to claim a place here. The subject is that of a wounded man, who, given over by his physician, is miraculously healed in a vision by St. Francis. The chief group of the picture represents the sick man, who, extended on his bed, is looking up with a stedfast countenance at the saint, who is laying his hand upon the wound. Two angels accompany St. Francis, one of whom holds a box of ointment. In another part of the picture the physician is represented about to go out of the room door, followed by a woman, evidently a sister or near relative of the wounded man, who, with a taper in her hand, has been conducting him to the bedside. She is earnestly attentive to what the physician is saying to the father, who has been waiting for them at the outside of the door, and who shews by his gestures, which the tears of the young woman corroborate, that no hopes are given of his son's recovery.

In the two pictures last mentioned, the different figures admitted were essential to the perfect explanation of the story. Sometimes, however, a group, or figure, which, although not necessary, shall nevertheless appear naturally, as it were, to grow out of the subject, may be introduced with great augmentation of the expression and effect of the piece. Such was the pathetic episode of Aristides, so repeatedly imitated in modern times by Poussin, and other painters. A town taken by storm was the subject of this picture, in one part of which an infant was introduced creeping to the breast of its mother, who, though expiring from her wounds, yet expressed the strongest apprehension and fear lest the course of her milk being stopped, the child should suck her blood.

The judicious disposal of the materials furnished by the imagination, or invention, in such a manner as best to contribute to the beauty, the expression, and the effect of the picture, constitutes what is termed composition in painting. And here we must observe, that the different parts of the art, before mentioned, are so intimately connected with, and so dependant on each other, that the separate discussion of them must ever be attended with great difficulty, and necessarily occasion a frequent recurrence to similar arguments and principles. Composition is more especially inseparable from the rest, as not only the necessary expression of the subject and the forms and distribution of the groups, but likewise the consequent lights and shades resulting from such forms and distribution, the contrast and variety of the characters,

and even the principal masses of colour, all, in a certain degree, come under the consideration of the artist, even when making his first sketch.

It were in vain to prescribe any other general rule for the distribution of the figures in a picture, except such as is dictated by the peculiar circumstances and character of the story to be represented. Much has been said of the pyramidical group, the serpentine line, the artificial contrast, and, upon doctrines like these, Lanfranco, Cortona, Giordano, Maratti, and many others, their predecessors, as well as followers, formed a style better calculated to amuse the eye than to satisfy the judgment: an inordinate but ill directed thirst of variety is the basis of this artificial system; contrast is succeeded by contrast, opposition by opposition; but as this principle pervades all their works, the result is no variety at all, and their conduct may be compared to that of the voluptuary, who, grasping at every enjoyment which presents itself, acquires satiety instead of pleasure. Each subject, however different its character, is composed in a manner so similar to the other, that the spectator may view a gallery of such pictures, seldom discovering the subjects they are intended to represent, and without being afterwards enabled to call to mind one prominent feature distinguishing the one from the other.

If Raffaele can be said to have regulated his compositions by any particular rule or maxim, it was that of making each as unlike the other as possible, consistent with propriety of expression. Thus, in the cartoon of Christ giving the keys to Peter, the Apostles, all crowding together to be witnesses of the action, occupy the principal part of the picture, and form a group in profile, the Saviour, although in the corner of the picture, being nevertheless rendered evidently the principal figure, by the insulated situation given to him, as well as by the actions of the Apostles, who all press forward towards him, as to the centre of attraction. This cartoon is finely contrasted by the magnificent composition representing the death of Ananias, where the Apostles form a group in the centre, and are all seen in front. That of Peter and John healing the cripple at the beautiful gate of the temple is again strikingly different from either of its companions, Raffaele having there, with a boldness of which any but a sublime genius would have been incapable, intersected his composition by the columns of the portico. But though divided, it is true, into separate and almost equal parts, neither the unity of action, nor the expression of the picture, is impaired, whilst the effect produced is at once novel and beautiful.

In the process of painting, design may properly be said to follow next after composition; for although this part of the art is, in a certain degree, requisite, even in making the first rough sketch, it is not until afterwards that the artist exerts his utmost powers to give that exact proportion, that beauty of contour, and that grace and dignity of action and deportment to his figures, which constitute the perfection of design: that which was first only hinted at is now to be defined: a few rude and careless lines were sufficient in the sketch to indicate the general attitude and expression of the figure, now the utmost precision is required, not only in the outline of the naked parts, but even in the delineation of the most complicated windings of a lock of hair, or the intricate folds of a drapery. A very high degree of excellence in design is perhaps justly considered the greatest difficulty of painting. Many of the works of Raffaele, and his school, leave nothing to be desired on the score of composition and expression. Colouring was carried to its highest pitch by Giorgione and Titian; chiaro-scuro by Coreggio, Rubens, Rembrant, and others of the Dutch school; but any thing approaching to perfection of design, if we except some of the figures of the great Michael Angelo, is rarely to be witnessed in the productions of modern art. The noble works of Grecian sculpture still remaining, sufficiently declare the decided superiority of the ancients in this particular; a superiority indeed which the most enlightened judges have never ventured to dispute.

The light clothing of the Grecian youth, which only half concealed the forms it covered, whilst it allowed full scope to the action and growth of the limbs; their ceremonies, their athletic games and dances, frequently performed naked; the great respect in which the arts of design were held amongst them, insomuch that the most beautiful of both sexes aspired to become the models of the painter or the sculptor: all these advantages, independently perhaps of some others which might be named, the artists of antiquity exclusively enjoyed, and we cannot therefore be surprised that their minds were better stored with the ideas of fine form,

and that they were better enabled to discriminate between the different degrees of beauty, and the varieties of character in the human frame, than is the lot of modern artists, unaided as they are by such opportunities of study.

The most perfect knowledge of form, however, only constitutes a part of that branch of painting which we term design: the art of fore-shortening, by which a limb, or a figure, although only occupying a diminished space on the canvas, is rendered, in appearance, of its full length and magnitude, is an equally indispensable object of the artist's attainment. The sculptor, when he has chisseled or modeled the form of his figure or group, with its just proportions, has completed his work, which is rather the simple transcript than the imitation of the image previously formed in his mind: his art is undisguised, and without illusion: it presents as well to our touch as to our sight, the bodies and shapes of things without the colour. The distinguishing prerogative of painting, on the other hand, and that from which arises its decided advantage over every other artificial mode of representation, is its power to give upon a limited plane the appearance of boundless space. An insight to the science of perspective, and the doctrines of lights and shadows, is indispensable, ere the student can hope to acquire the art of fore-shortening his figures with correctness; an art in which the great Michael Angelo has evinced such consummate skill in his frescoes in the Sestine Chapel at Rome, that they can never be sufficiently contemplated. The works of Coreggio, and in particular his two cupolas at Parma, may likewise be studied with advantage, and sufficiently prove that even the boldest fore-shortenings may on many occasions be resorted to, without detriment to the beauty, the grace, or expression of the figures In the execution of these, and most of his chief works, however, he was greatly assisted by his friend Antonio Begarelli, a celebrated Modenese sculptor, who modelled for him in clay all the figures, so that Coreggio, by placing and grouping them together as they were to be represented, was enabled to delineate, with the greatest correctness, every fore-shortening, and at the same time to acquire a truth and boldness of light and shade unattainable by other means. And here it may be well to observe, that the trouble of preparing such models in the first instance, is amply repaid by the great facility, or rather certainty, which it gives the artist in the execution of his work. Moreover, the painter having his modelled figures before him, and being enabled, by varying the situation of his eye, to view them in every direction, will frequently discover beautiful combinations which he never dreamed of, at the same time that he is rendered less liable to the error of too often repeating the same view of a figure, or the same action, and is taught to avoid a common place mode of composition.

We have styled expression one of the component parts of painting, although, as it is wholly the result of the powers which the artist possesses of embodying his feelings by means of lines, lights and shades, and colours, it cannot truly be said to have a separate existence. But be this as it may, a thorough knowledge of the passions, and the power of representing justly their various effects on the action and countenances of men, requires the most consummate skill of the painter. The more violent emotions of the soul, having naturally an instantaneous effect on the action, as well as on the countenance of the person affected, can be, with the greater facility, effectually and unequivocally expressed in painting. To delineate the nicer discriminations of gentle affections, of thought, sentiment and character, is a far more arduous task, and indeed not always crowned with success, even in the attempts of the greatest masters; this alone would be sufficient to convince us that subjects admitting of action, and strong decided expression, are more especially within the province of our art. The proper expression of the subject is, as we have before stated, the end proposed by the artist, even in the invention and composition of his piece. In the style of design, in the chiaro-scuro and colouring of the picture, the same object should be stedfastly kept in view.

Clair obscure, or chiaro-scuro, is the art of distributing the lights and darks in a picture, in such a manner as to give at once proper relief to the figures, the best effect to the whole composition, and the greatest delight to the eye. We have said the lights and darks in a picture, because the word chiaro-scuro, properly speaking, denotes not only light and shade, but light and dark of what kind soever, and in this sense it is nearly allied to colouring, if not indeed inseparable from it. A thorough conception and knowledge of the chiaro-scuro is of the

greatest importance to a painter, as it is very chiefly by the proper application of this branch of the art, that he is enabled to make the various objects in his picture appear to project or recede, according to their relative situations or distances; and thus far, indeed, the principles of it are necessary to the artist, ere he can hope to render his imitation just or intelligible. But it is required in works of fine art, not only that truth should be told, or that beauty should be represented, but likewise that the one and the other should be made appear to every possible advantage; it has, therefore, ever been the study of great painters, not only to give the due appearance of roundness or projection to the objects in their pictures, by proper lights and shadows; but likewise to unite or contrast the masses of light and dark in such a manner as to give at once the most forcible impression to the imagination, and the most pleasing effect to the eye.

Leonardo da Vinci was the first artist of modern times who treated the subject of chiaro-scuro scientifically; but although he gave great force and softness to his pictures, yet the system which he recommended, and generally adopted, of relieving the dark side of his figures by a light back ground, and the light parts by a dark one, prevented that expansion and breadth of effect, which Coreggio soon after discovered could only be attained by a contrary mode of conduct, that of relieving one shadow by another still darker, and of uniting several light objects into one great mass. The figures, as well as the other objects in the pictures of Coreggio, are at all times so disposed, as naturally to receive the light exactly in those parts where it is most wanted, and best suits the effect of the whole, and yet this is done so skilfully, that neither propriety nor grace of action seems in any respect to be sacrificed in the astonishing combination.

The principal painters of the Venetian school, Giorgione, Titian, Bassan, Tintorit, and Paulo Veronese, were masters of effect; but with them this effect is more frequently the result of accordance, or opposition of the local colours of the different objects composing their pictures, than of any very studied or skilful disposition of the masses of light and shadow. Rubens, the great genius of the Flemish school, united the wide expansive effect of Corregio, the richly contrasted tints of the Venetians, and the force of Caravaggio, and has only left us to regret that his magnificent and bold inventions were not designed with the purity of Raffaele, or the correctness of Buonaroti. From the scanty introduction of light in the works of Rembrant, we might be led to suppose that this surprizing artist considered the illumined parts of his pictures as gems, acquiring increased lustre from their rarity; whilst the striking effects he has thereby produced, happily teaches us, how vain the attempt to limit or restrain by rules the workings of genius in the human mind. From an attentive study of the works of these great masters, the student will derive the true principles of chiaro-scuro, and be the better qualified to seize and avail himself of those transcient, but beautiful effects, which nature, the great master of all, every day presents to his eyes. It remains for us to say a few words on colouring.

Colouring is the art of giving to every object in a picture its true and proper hue, as it appears under all the various circumstances or combinations of light, middletint, and shadow; and of so blending and contrasting the colours, as to make each appear with the greatest advantage and beauty, at the same time that it contributes to the richness, the brilliancy, and the harmony of the whole. "Should the most able master in design," says Mr. Webbe, "attempt, by that alone, a rose or grape, we should have but a faint and imperfect image; let him add to each its proper colours, we no longer doubt, we smell the rose, we touch the grape."

Colouring, like chiaro-scuro, (and the same observation applies to the other parts of the art) may be divided into two kinds; that which is necessary for rendering the imitation just and intelligible, and that which is expedient or ornamental, as contributing to render the work more impressive to the imagination, and more harmonious and delightful to the eye. In the first kind truth in the local tints is alone required; the second demands choice in their selection and distribution.

The Bellini's, of Venice, towards the close of the fifteenth century, first began to discover the beautiful effects resulting from a skilful combination, or opposition, of colours, at the same time that they attained a richness and truth in their local tints, far exceeding any thing hitherto practised. In both these qualities, how-

ever, they were soon far surpassed by their scholars, Giorgione da Castel Franco, and Titian, who, superadding to the most astonishing richness of colour the powerful light and shade of da Vinci, produced works which, in their way, have baffled all future attempts at improvement. The tone of colour of their pictures is not that of nature in her every-day garb; it is in some respects ideal, like the chiaro-scuro of Corregio and Rubens, or the design of Michael Angelo; that which may be supposed, but which is seldom found in nature: the depth and mellowness of their tints seem the effect of a tranquil, but vigorous light, shining through the heated atmosphere of a summer's evening. And here it may not be foreign to our purpose to observe, that there seems to be nothing in the colouring of Titian and Giorgione incompatible with the greatest purity of design, sublimity of conception, or propriety of expression; whereas the splendid extravagances, the brocaded stuffs, the gaudy trappings of the greater part of the more modern Venetians, although they were perhaps all masters of the theory of colours, are wholly inconsistent with genuine expression and true grandeur: in short, the sober senatorial dignity of Titian was soon changed for show, for glitter, and for ornament; invention, composition, design, and expression, were all made subservient to the inordinate desire of effect of colour.

The short limits of this article will not permit us to mention the numerous artists who have excelled in chiaro-scuro and colouring. These parts of the art, being more especially calculated to give pleasure to the sight, have been more generally and more successfully practised, than the arduous and less flattering task of rational and expressive composition, and correct design.

In the present enquiry it has been our chief aim to enforce such arguments as are calculated to draw the attention of the reader to the legitimate end of the art; that, whilst the eye is charmed with beautiful forms, the magic of chiaroscuro, and the richness and harmony of colours, the due expression of the subject of a piece may be attained, it were folly to deny: this union, indeed, constitutes the perfection of painting, which should convey, like fine writing, truths to the mind in language at once the most forcible and beautiful; but an attempt to point out the means by which this delight may be conveyed to the sight, would necessarily require a minute investigation of all the different modes which it is in the power of the painter to adopt in the executive departments of his art; and consequently lead us, with perhaps, after all, little prospect of success, far beyond the limits we are obliged to prescribe to ourselves.

Simplicity with variety, inequality of parts, with union in the whole, are, perhaps, the basis of all those effects in painting which give pleasure to the sight. As in a composition one group, or one figure, should strike the eye with superiority over the secondary groups, or other objects in the picture; so there should be in a picture one principal mass of light, which, however connected with others, should still predominate; and for the same reason no two colours should have equal sway in the same picture; as we are at liberty to give the chief group or figure of the composition that situation which we judge most appropriate; so there is no rule by which we are obliged to place the principal light in any one given part of the picture. In clair-obscure, an inequality of parts, a subordination of several small masses to one large one, never fails to produce richness and beauty of effect; and thus, in composition, a similar richness and beauty are the result of an opposition of several small bodies or parts to one large and simple; and in the same manner, from an arrangement of several small masses of colour in the vicinity of one large mass, the latter seems enriched, and to acquire additional consequence and beauty.

As by the addition of smaller masses of light, connected with the principal mass, that mass acquires at once greater breadth and influence, so the unity of action in a composition is in many cases powerfully augmented by a repetition of nearly the same action in two or three of the accessorial figures arranged together, one nevertheless being principal: this was the frequent custom of Raffaele, has its foundation in nature, where similar sentiments most frequently excite similar outward demonstrations, and never fails, if judiciously managed, to produce its effect.

The doctrine of contrasts is equally applicable to composition, to clair-obscure, and to colouring. As in composition the too frequent contrast of lines, or of back to front figures, is destructive of simplicity and force of expression; so the inordi-

nate and frequent introduction of strong oppositions of lights and shadows, or of colours, produces a spotty and confused appearance, wholly subversive of breadth and grandeur of effect; the moderate and judicious use of contrasts is of the greatest use; it gives a zest to the picture, and is like the discord in music, which sheds additional sweetness on the full harmony which succeeds it.

PAIR, in anatomy, an assemblage or conjugation of two nerves, which have their origin together in the brain, or spinal marrow, and thence distributed into the several parts of the body, the one on one side, and the other on the other.

PALEÆ, in botany, thin, membranaceous, chaffy plates, springing out of a common receptacle, and intended as lines of partition between the small partial florets of compound and aggregate flowers.

PALAMEDEA, the *screamer*, in natural history, a genus of birds of the order Grallæ. Generic character: bill conic, the upper mandible hooked; nostrils oval; toes divided nearly to their origin, with a small membrane between the bottoms of each. There are two species. The horned screamer is about as large as a common turkey, and has on the crown of its head a slight horn, rising perpendicularly about three inches in length. It feeds on herbs and seeds, and, some add, on reptiles. It is found in Guiana, and other neighbouring territories of South-America, principally in the low and marshy grounds. These birds are never observed but in pairs, and so faithful, tender, and constant is their attachment, that the death of one is generally attended with a degree of distress and grief which destroys the other. They are eaten by the natives while young; but their flesh is very darkly coloured, though not ill tasted. The crested screamer inhabits Brazil, and is about as large as a heron, and feeds on the same substances as that bird. It is esteemed good for the table.

PALATE, in anatomy, the flesh that composes the roof, or the upper and inner part of the mouth. See ANATOMY.

PALAVIA, in botany, so named in honour of Don Antonio Palau, an eminent botanist, a genus of the Monadelphia Polyandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character; calyx half, five-cleft; style many-cleft; capsule many-celled; cells in a ball on the raised central receptacle. There are two species: *viz.* P. malvifolia, and P. moschata: these are both annuals, and natives of Lima in Peru, where they were discovered by Dombey.

PALE, a little pointed stake or piece of wood, used in making inclosures, separations, &c. The pale was an instrument of punishment, and execution, among the ancient Romans, and still continues so among the Turks. Hence empaling, the passing a sharp pale up the fundament through the body.

PALE, in heraldry, one of the honourable ordinaries of an escutcheon; being the representation of a pale or stake placed upright, and comprehending the whole height of the coat from the top of the chief to the point. When the pale is single, it is to contain one third of the breadth of the shield. When there are several, more properly called pallets, they are proportioned so as that two take up two-fifths of the shield, and three take up three sevenths; and in those cases the number of pieces are specified, as well as that of those they are charged withal, &c. Pales are borne various ways, as wavy, indented, ingrailed, inverted, &c. There are also cometed and flaming pales, which are pointed, sometimes waved, &c.

PALISADE, or PALISADO, in fortification, an enclosure of stakes or piles driven into the ground, each six or seven inches square, and eight feet long, three whereof are hidden under ground. Palisadoes are generally used to fortify the avenues of open forts, gorges, half-moons, the bottoms of ditches, the parapets of covert ways, and in general all posts liable to surprise, and to which the access is easy. Palisadoes are usually planted perpendicularly, though some make an angle inclining towards the ground next the enemy, that the ropes cast over to tear them up may slip.

PALISADE, in gardening, denotes a sort of ornament; being a row of trees which bear branches and leaves from the bottom, cut and spread in manner of a wall along the side of an alley, or the like, so as to appear like a wall covered with leaves.

PALISSE, in heraldry, a bearing like a range of palisades before a fortification, represented on a fesse, rising up a considerable height, and pointed a-top, with the field appearing between them.

PALLADIUM, in chemistry, a metal discovered by Dr. Wollaston in the native platina: it is of a greyish colour, and, when polished, of considerable lustre: it

is very ductile and very malleable; so that by the flatting mill it can be reduced into thin slips, which are flexible, but not very elastic. Its fracture is fibrous, and in diverging striæ, shewing a kind of crystaline arrangement. In hardness it is superior to wrought iron. Its specific gravity varies according to its perfect fusion, and as it is more or less porous, from hammering or flatting, from 10.9 to 11.8. It is a less perfect conductor of caloric than the other metals, and is also less expansible. When exposed to a strong heat, its surface tarnishes a little, and becomes blue, but by increasing the heat it again becomes bright. By a very great heat it is fused. It is not oxided by heat; its oxides formed by the action of acids are reduced by means of a high temperature. It is acted upon by a number of the acids; and the solutions formed by them may be decomposed by the alkalies and earths; precipitates being thrown down, which are generally of a beautiful orange colour. The alkalies act likewise on palladium even in the metallic state: the action is promoted by the contact of the atmospheric air. All the metals, except gold, silver, and platina, precipitate palladium from its solution in the metallic state. Palladium combines readily with sulphur, but not with charcoal. It may be alloyed with a number of the metals. A full account of the discovery of palladium, with the controversy to which it gave rise, will be found in the Philosophical Transactions for the years 1802, 1803, 1804, 1805.

PALLASIA, in botany, so named in honour of Peter Simon Pallas, M. D. a genus of the Syngenesia Polygamia Frustranea class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: receptacle, chaffy; down none; seeds vertical, flat, margin ciliated; calyx, imbricate. There is but one species, *viz.* P. halimifolia, a native of Lima, in Peru.

PALLET, among painters, a little oval table, or piece of wood or ivory, very thin and smooth; on, and round which, the painters place the several colours they have occasion for, to be ready for the pencil. The middle serves to mix the colours on, and to make the tints required in the work. It has no handle, but instead thereof a hole at one end, to put the thumb through to hold it.

Pallet, among potters, crucible makers, &c. a wooden instrument, almost the only one they use, for forming, heating, and rounding their works: they have several kinds; the largest are oval, with a handle; others are round, or hollowed triangularly; others, in fine, are in manner of large knives, serving to cut off whatever is superfluous on the moulds of their work.

Pallet, in gilding, an instrument made of a squirrel's tail, to take up the golden leaves from the pillow, and to apply and extend them on the matter to be gilt. See Gilding.

Pallet, in heraldry, is nothing but a small pale, consisting of one half of it in breadth, and therefore there are sometimes several of them upon one shield.

Pallet is also a part belonging to the balance of a watch or movement. See Watch.

Pallet, in ship-building, is a room within the hold, closely parted from it, in which, by laying some pigs of lead, &c. a ship may be sufficiently ballasted, without losing room in the hold, which, therefore, will serve for the stowing the more goods.

PALLIUM, or Pall, an archiepiscopal vestment of white woollen cloth, about the breadth of a border, made round, and thrown over the shoulders. Upon this border there are two others of the same matter and form, one of which falls down upon the breast, and the other upon the back, each having a red cross upon it; several crosses of the same colour being likewise upon the upper part of it about the shoulders. The pall was part of the imperial habit, and originally granted by the emperors to patriarchs; but at present it is given by the Pope as a mark of the apostolic power, without which neither the function nor title of archbishop can be assumed by the bishops of his communion.

PALM, an ancient measure, taken from the extent of the hand. The Roman palm was of two kinds: the great one was equal to about 8½ inches English: the small one to about three inches. The modern palm differs in different countries:

	In Lines.
At Rome it is	8 3½
At Genoa	9 9
In France	the same.
The English palm	3 0.

PALMÆ, in botany, *palms*. Under this name Linnæus has arranged several genera, which he has placed apart in an appendix to the work. The same plants constitute one of the seven families or tribes, into which all vegetables are dis-

tributed by Linnæus in his "Philosophia Botanica." They are defined to be plants with simple stems, which, at their summit, bear leaves resembling those of the ferns, being a composition of a leaf and a branch; and whose flowers and fruit are produced on that particular receptacle, or seat, called a spadix, protruded from a common calyx in form of a sheath or scabbard, termed by Linnæus "spatha."

Palmæ, is likewise the name of the first order in Linnæus's "Fragments of a Natural Method," consisting of the following genera; the three last of which, although not ranged with the palms in the appendix to his "Artificial System," are placed with them, on account of their alleged conformity in point of habit, in his "Natural Method." The plants of this order are perennial, and mostly of the shrub and tree kind. The stem is in height from two to a hundred feet, and upwards. The roots form a mass of fibres, which are commonly simple, that is, without any ramifications. In frog's-bit the roots are terminated by a small cup, of a conic form, which covers them like an extinguisher, as in duck's-meat. The stem is generally simple, cylindrical, and composed of strong longitudinal fibres; the leaves, which are a composition of a leaf and a branch, termed by Linnæus frondes, are of different forms, being sometimes shaped like an umbrella or fan, sometimes singly or double-winged; the small or partial leaves, which are often three feet in length, being ranged alternately; the branches, or principal leaves, are six, eight, ten, and twelve feet long, the length varying according to the age and size of the plant; the flowers are male and female upon the same or different roots, except in the water-soldier, which bears hermaphrodite flowers only; and the palmetto, in which the flowers are hermaphrodite and male upon distinct roots. In vallisneria and frog's-bit, too, the flowers are not so properly male and female upon different roots, as barren hermaphrodites; a small seed-bud being discovered in those called the male flowers, and the remains of stamina in the female. Abortive flowers of the same kind are frequently observed in vallisneria upon the same root. The common calyx in this order is that sort termed a spatha, or sheath, and has either one valve or opening, as in date-tree and cocoa-nut; or two, as in faufel-nut, and wild Malabar-palm. The spadex, or head of flowers protruded from the sheath, is generally branched. Each flower is commonly furnished with a perianthium, or proper flower-cup, consisting of three leaves or divisions, that are small and permanent; the petals are three in number, of a substance like leather, and permanent like the leaves of the calyx. The flowers of zamia have no petals; the stamina are in number from two to twenty, and upwards, and cohere slightly at the base. In frog's-bit they appear like a pillar in the centre of the flower; the seed-buds are from one to three in number, placed in the middle of the flower, and support a like number of styles, which are very short. In frog's-bit, vallisneria, and water-soldier, the seed-bud is placed under the receptacle of the flower; the seed vessel is generally a pulpy fruit of the berry or cherry kind, containing one cell, filled with fibrous flesh, and covered with a skin, which is of a substance like leather; the seeds are in number from one to three in each pulpy fruit, of a hard bony substance, round or oval, and attached by their base to the bottom of the fruit.

PALMATED, something resembling the shape of the hand: thus we say palmated leaves, roots, stones, feet of birds, &c.

PALSY, in medicine, a disease wherein the body, or some of its members, lose the power of motion, and sometimes their sensation of feeling.

PALY, or Pale, in heraldry, is when the shield is divided into four or more equal parts by perpendicular lines falling from the top to the bottom. Palybendy is when the escutcheon is divided by perpendicular lines, which is paly; and also by diagonals, which is called bendy. See Bendy.

PANACEA, among physicians, denotes an universal medicine, or a remedy for all diseases.

PANAX, in botany, a genus of the Polygamia Dioecia class and order. Natural order of Hederaceæ. Araliæ, Jussieu. Essential character: umbellateæ; corolla five-petalled; stamina five: hermaphrodite, calyx five-toothed, superior; styles two; berry two-seeded: male, calyx entire. There are nine species.

PANACRATIUM, in botany, a genus of the Hexandria Monogynia class and order. Natural order of Spathaceæ. Narcissi, Jussieu. Essential character: petals six; nectary twelve-cleft; stamina placed

on the nectary. There are ten species. This genus consists of perennial bulbous-rooted plants, from whence proceed long narrow leaves, and a strong upright scape, two feet in height, terminated by a large spathe, bursting on one side, disclosing in some of the species many, in others only one or two white flowers of great elegance and fragrance. They are chiefly natives of America and the West Indies.

PANCREAS, in anatomy, popularly called the sweet-bread, is a large gland, of a flattish shape and fleshy colour, extended behind the stomach, and reaching from the duodenum transversely towards the spleen. See ANATOMY.

PANCREATIC *juice*, a liquid secreted by the pancreas, which is found to be analogous to saliva, and probably serves the same purpose in promoting the digestion of the food. See PHYSIOLOGY.

PANDANUS, in botany, a genus of the Dioecia Monandria class and order. Essential character: calyx and corolla none: male, anther sessile, inserted into the ramifications of the spadix: female, stigmas two; fruit compound. There is but one species, *viz.* P. odoratissimus, sweet-scented pandanus. It is a native of the warmer parts of Asia, where it is much used for hedges; it grows readily from branches; the tender white leaves of the flowers yield that most delightful fragrance, for which they are so generally esteemed. Of all the perfumes it is by far the richest and most powerful; the lower yellow pulpy part of the drupe is sometimes eaten by the natives in times of scarcity and famine; also the tender white base of the leaves, either raw or boiled.

PANDECTS, in the civil law, collections made by Justinian's order, of five hundred and thirty-four decisions of the ancient lawyers, on so many questions occurring in the civil law: to which that Emperor gave the force and authority of law, by an epistle prefixed to them. The pandects consist of fifty books, and make the first part of the body of the civil law.

PANIC, denotes an ill-grounded terror or fright. The origin of the phrase is from Pan, one of the captains of Bacchus, who, with a few men, put a numerous army to rout, by a noise which his soldiers raised in a rocky valley favoured with a great number of echoes; for this stratagem making their number appear much greater than it really was, the enemy quitted a very commodious encampment, and fled. Hence all ill-grounded fears have been called panics, or panic fears.

PANICLE, in botany, denotes a soft woolly beard, on which the seeds of some plants, as millets, reeds, &c. hang.

PANICULA, in botany, a mode of flowering, in which the fructifications are dispersed upon footstalks variously subdivided. It is a sort of branching or diffused spike, composed of a number of small spikes that are attached along a common foot-stalk. The term is exemplified in oats, panic-grass, &c.

PANICUM, in botany, *panic-grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, the third valve very small. There are seventy-nine species. For an account of this very numerous genus, we refer the reader to Martyn's edition of Miller's Botany.

PANIERS, baskets used in fortification. In military affairs the term is expressive of a man dangerous to society, of one who ought to be guarded against where confidence and discretion are necessary.

PANEL, in law, an oblong piece of parchment, containing the names of the jurors, annexed to the writ of *venire facias*, and returned by the Sheriff to the court from whence the process issued. From this the jury is often called the panel, and are said to be impanelled.

PANNAGE, or PAWNAGE in law, the fruit of trees, as acorns, crabs, nuts, mast of beech, &c. which the swine feed upon in the woods, and which in some places the inhabitants take as a right of common.

PANNEL, in joinery, is a tympanum, or square piece of thin wood, sometimes carved, framed, or grooved in a larger piece, between two upright pieces and two cross-pieces.

PANORPA, in natural history, a genus of insects of the order Neuroptera: mouth lengthened into a cylindrical horny proboscis; feelers four, nearly equal; stemmata three; antennæ filiform, longer than the thorax; tail of the male armed with a chelate appendage; of the female unarmed. There are nine species, the most familiar is, as its name imports, P. Fasciata, an insect very frequently seen in meadows during the early part of the summer. It is a longish bodied fly, of moderate size, with four yellowish wings,

elegantly variegated with black dots and bands; the tail of the male insect, which is generally carried in an upright position, is furnished with a forceps, somewhat in the manner of a lobster's claw. P. coa, inhabits the Greek islands; upper wings spotted with brown, lower ones extremely narrow, and as long again as the upper pair, alternately brown and yellowish. It is much larger than the communis, and is distinguished by its beautiful colours.

PANTOMETER, the name of an instrument used to take all sorts of angles, distances, and elevations.

PAPAVER, in botany, *poppy*, a genus of the Polyandria Monogynia class and order. Natural order of Rhoeadeæ. Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla four-petalled; capsule one-celled, opening by holes under the permanent stigma. There are nine species. See POPPY.

PAPER, sheets of a thin matter, made of some vegetable substance. The materials on which mankind have, in different ages, contrived to write their sentiments, have been extremely various; in the early ages they made use of stones, and tables of wood, wax, ivory, &c. Paper, with regard to the manner of making it, and the materials employed therein, is reducible to several kinds; as Egyptian paper, made of the rush papyrus; bark paper, made of the inner rind of several trees; cotton paper; incombustible paper; and European paper, made of linen rags.

Egyptain paper was principally used among the ancients; being made of the papyrus, or biblus, a species of rush, which grew on the banks of the Nile: in making it into paper, they began with lopping off the two extremes of the plant, the head and the root: the remaining part, which was the stem, they cut lengthwise into two nearly equal parts, and from each of these they stripped the scaly pellicles of which it consisted. The innermost of these pellicles were looked on as the best, and that nearest the rind as the worst: they were therefore kept apart, and made to constitute two different sorts of paper. As the pellicles were taken off, they extended them on a table, laying them over each other transversely, so as that the fibres made right angles; in this state they were glued together by the muddy waters of the Nile; or, when those were not to be had, with paste made of the finest wheat flour, mixed with hot water and a sprinkling of vinegar. The pellicles were next pressed, to get out the water, then dried, and lastly flatted and smoothed by beating them with a mallet: this was the Egyptian paper, which was sometimes further polished by rubbing it with a glass ball, or the like.

Bark paper was only the inner whitish rind, inclosed between the bark and the wood of several trees, as the maple, plane, beech, and elm, but especially the tilia, or linden tree, which was that mostly used for this purpose. On this, stripped off, flatted, and dried, the ancients wrote books, several of which are said to be still extant.

Chinese paper is of various kinds; some is made of the rinds or barks of trees, especially the mulberry tree and elm, but chiefly of the bamboo and cotton tree. In fact, almost each province has its several paper. The preparations of paper made of the barks of trees may be instanced in that of the bamboo, which is a tree of the cane or reed kind. The second skin of the bark, which is soft and white, is ordinarily made use of for paper: this is beat in fair water to a pulp, which they take up in large moulds, so that some sheets are above twelve feet in length: they are completed by dipping them, sheet by sheet, in alum water, which serves instead of the size among us, and not only hinders the paper from imbibing the ink, but makes it look as if varnished over. This paper is white, soft, and close, without the least roughness, though it cracks more easily than European paper; is very subject to be eaten by the worms, and its thinness makes it liable to be soon worn out.

Cotton paper is a sort of paper which has been in use upwards of six hundred years. In the grand library at Paris are manuscripts on this paper, which appear to be of the tenth century; and from the twelfth century, cotton manuscripts are more frequent than parchment ones. Cotton paper is still made in the East Indies, by beating cotton rags to a pulp.

Linen or European paper appears to have been first introduced in England towards the beginning of the fourteenth century, but by whom this valuable commodity was invented is not known. The method of making paper of linen or hempen rags is as follows: the linen rags being carried to the mill, are first sorted; then washed very clean in puncheons, whose sides are grated with strong wires, and the bottoms bored full of holes. After this they are fermented, by laying them in heaps close covered with sack-

ing, till they sweat and rot; which is commonly done in four or five days. When duly fermented, they are twisted into handfuls, cut small, and thrown into oval mortars, made of well-seasoned oak, about half a yard deep, with an iron plate at bottom, an inch thick, eight inches broad, and thirty long; in the middle is a washing block, grooved, with five holes in it, and a piece of hair sieve fastened on the inside: this keeps the hammers from touching it, and prevents any thing from going out, except the foul water. These mortars are continually supplied with water, by little troughs, from a cistern, fed by buckets fixed to the several floats of a great wheel, which raises the wooden hammers for pounding the rags in the mortars. When the rags are beaten to a certain degree, called the first stuff, the pulp is removed into boxes, made like cornchandlers' bins, with the bottom board aslant, and a little separation on the front, for the water to drain away. The pulp of the rags being in, they take away as many of the front boards as are needful, and press the mass down hard with their hands: the next day they put on another board, and add more pulp, till the box is full, and here it remains mellowing a week, more or less, according to the weather. After this, the stuff is again put into clean mortars, and is beaten afresh, and removed into boxes, as before; in which state it is called the second stuff. The mass is beat a third time, till some of it being mixed with fair water, and strewed to and fro, appears like flour and water, without any lumps in it; it is then fit for the pit mortar, where it is perfectly dissolved, and is then carried to the vat, to be formed into sheets of paper. But lately, instead of pounding the rags to a pulp with large hammers, as above, they make use of an engine, which performs the work in much less time. This engine consists of a round solid piece of wood, into which are fastened several long pieces of steel, ground very sharp. This is placed in a large trough with the rags, and a sufficient quantity of water. At the bottom of the trough is a plate with steel bars, ground sharp like the former; and the engine being carried round with prodigious velocity, reduces the rags to a pulp in a very short time. It must be observed, that the motion of the engine causes the water in the trough to circulate, and by that means constantly returns the stuff to the engine. The trough is constantly fed with clean water at one end, while the dirty water from the rags is carried off at the other, through a hole, defended with wire gratings, in order to hinder the pulp from going off with the dirty water.

When the stuff is principally prepared as above, it is carried to the vat, and mixed with a proper quantity of water, which they call priming the vat. The vat is rightly primed, when the liquor has such a proportion of the pulp, as that the mould, on being dipped into it, will just take up enough to make a sheet of paper of the thickness required. The mould is a kind of sieve, exactly of the size of the paper to be made, and about an inch deep, the bottom being formed of fine brass wire, guarded underneath with sticks, to prevent its bagging down, and to keep it horizontal; and further, to strengthen the bottom, there are large wires placed in parallel lines, at equal distances, which form those lines visible in all white paper, when held up to the light: the mark of the paper is also made in this bottom, by interweaving a large wire in any particular form. This mould the maker dips into the liquor, and gives it a shake as he takes it out, to clear the water from the pulp. He then slides it along a groove to the coucher, who turns out the sheet upon a felt, laid on a plank, and lays another felt on it, and returns the mould to the maker, who by this time has prepared a second sheet, in another mould; and thus they proceed, laying alternately a sheet and a felt, till they have made six quires of paper, which is called a post; and this they do with such swiftness, that, in many sorts of paper, two men make twenty posts or more in a day. A post of paper being made, either the maker or coucher whistles; on which four or five men advance, one of whom draws it under the press, and the rest press it with great force, till all the water is squeezed from it; after which it is separated, sheet by sheet, from the felts, and laid regularly one sheet upon another; and having undergone a second pressing, it is hung up to dry. When sufficiently dried it is taken off the lines, rubbed smooth with the hands, and laid by till sized, which is the next operation. For this they choose a fine temperate day, and having boiled a proper quantity of clean parchment or vellum shavings in water, till it comes to a size, they prepare a fine cloth, on which they strew a due proportion of white vitriol and roch-alum, finely powdered, and strain the size through it, into a large tub; in which

they dip as much paper at once as they can conveniently hold, and with a quick motion give every sheet its share of the size, which must be as hot as the hand can well bear it. After this the paper is pressed; hung up sheet by sheet to dry; and, being taken down, is sorted, and, what is only fit for outside quires laid separately: it is then told into quires, which are folded and pressed. The broken sheets are commonly put together, and two of the worst quires are placed on the outside of every ream or bundle, and being tied up in wrappers, made of the settling of the vat, it is fit for sale.

Paper is of various kinds, and used for various purposes: with regard to colour, it is principally distinguished into white, blue, and brown; and with regard to its dimensions, into atlas, elephant, imperial, super-royal, royal, medium, demy, crown, fool's-cap, and pot paper.

Fig. 1, Paper Mill, is an elevation of an engine paper mill; (fig. 2) a plan; and (fig. 3) a section of it; the same letters refer to all the figures. It is contained in a square wooden chest, A B D E, lined with lead, and divided in the middle by a partition F F; on the front and back of the chest, two short beams, G G, *g g*, are bolted; they have long mortices through them to receive tenons, at the end of two horizontal levers, H H, which turn on bolts in one of the beams, G *g*, as centres, and are elevated or depressed by turning the nuts of two screws, *h h*, fixed to the tenon, and coming up through the top of the beams, G *g*, upon which the nuts take their bearing. Two brasses are let into the middle of the levers, H H, and form the bearing for the spindle, I I, of the engine to turn upon. K, is the cylinder, made of wood, and fixed fast upon the spindle, I I; it has a number of knives or cutters fixed on it, parallel to its axis, and projecting from its circumference about an inch. L, (fig. 3) is a circular breasting, made of boards, and covered with sheet-lead, which fits the cylinder very truly, and leaves but very little space between the teeth and the breasting, L. M, is an inclined plane, leading regularly from the bottom of the engine trough, to the top of the breasting; and N is another plane, but of smaller inclination, leading from the bottom of the breasting; at the bottom of the breasting, beneath the axis of the cylinder, a block, P, is fixed, it has cutters of the same size, and exactly similar to those in the cylinder, which pass very near to those in the block, but do not touch; this block is fixed by a dove-tail into the wooden bottom of the breasting; it comes through the wood-work of the chest, and projects a small distance from the outside of it, and is kept up to its place by a wedge, Q, (fig. 1); by withdrawing this wedge the block becomes loose, and can be removed to sharpen the cutters as occasion requires.

The cylinder is turned round with great velocity by a small pinion, E, turned by a cog-wheel, which is turned with the intervention of other wheels by a water-wheel, so as to revolve about one hundred and twenty times per minute. This great velocity draws the rags and water with which the engine-trough is filled, down between the cylinder and the fixed cutters in the block, P; and by this they are cut in pieces, and, passing round the partition, F F, come to the cylinder again: the breasting, L, by being so close to the cylinder, and its top so near the surface of the water, prevents the rags getting to the cylinder too fast, and by that means clogging it up, or raising it up from its bearing; and if any rags come to the breasting rolled up, the action of the cylinder against the breasting tends to open them, and bring them in their proper direction to the cylinder. The screws, *h h*, are used to raise or lower the cylinder, and cause it to cut finer or coarser by enlarging or diminishing the space between the cutters in the block, P, and those of the cylinder.

A cover is put over the cylinder to prevent the water and rags being thrown out of the engine by its great velocity; it is a square box, *a b d e*, and has two small troughs at *d* and *e*, coming through the sides of the box. *f g*, are two hair sieves, sliding in grooves made in each side of the box: the cylinder, as it turns, throws a great quantity of the water and rags up against these sieves; the water goes through them, and runs down the trough at *d* and *e*, and from thence into the end of leaden pipes, *h i*, (fig. 1), by which it is conveyed away: *k l*, are grooves for two boards, which, when slid down in their places, cover the hair sieves, and stop the water going through them. A considerable part of the rags thus thrown up by the cylinder, pass quite over it, and go down under it again.

The engine is constantly supplied with fair water by a pipe, R, delivering it into a small cistern communicating with the engine; the pipe has a flannel bag tied to the end to strain the water. In large

mills, two engines exactly similar are used, but one set to act finer than the other; the rags are first worked in the coarse one, and afterwards in the fine one; but some mills have but one engine, and alter it to cut fine by the screws, *h h.*

The paper proper for writing should be without knots, without any parts of the stuff not triturated, without folds, and without wrinkles, of a supple texture, its grain uniform and regular, softened in the exchange, and not destroyed by smoothing. The ground of this paper must be extremely white, or shaded with a very light blue, which adds to its natural splendor. It is of great importance that it be fully and equally sized, otherwise the writing cannot be well finished, and the turnings of the letters will be very imperfect. The paper used for drawing, or for coloured maps, is in some mills made from one kind of white stuff, either fine or middling; in others, from a mixture of three or four kinds of stuff of different colours. The Dutch were not long ago almost wholly in possession of this manufacture. The same qualities are necessary in this paper as in that for writing. The grain, however, must be a little more raised, although softened by the exchange; for, without this grain, the pencil would leave with difficulty the traces of the objects. Great care is also necessary in the sizing of this paper, that the drawing be neatly performed, and also that the sinking of the ink or colours into the irregularities of the stuff be prevented.

The British and Dutch have had the greatest success in manufacturing pasteboard, which they make either from a single mass of stuff on the form, or from a collection of several sheets pasted together. In both cases, the sheets of pasteboard are made of stuff not rotted, and triturated with rollers, furnished with blades of well tempered steel. By the operation of the exchange, and smoothing continued for a long time, the British and Dutch obtain solid and smooth stuffs, which neither break under the folds of cloth nor adhere to them. The stuffs not putrified have another advantage in this species of pasteboard, namely, that of resisting the action of heat, which they experience between the folds of cloth, without wasting or tarnishing, and of consequence, they may be used for a long time. In England they have at least equalled any other nation in the manufacture of this paper; and even in Scotland they have arrived at such a degree of perfection in this art, that great part of what they manufacture is sent into England. It requires to be made of a soft and equal stuff, without folds or wrinkles, of a natural whiteness, and with a shade of blue. It must be sized less strongly than writing paper, but sufficiently well to give neatness to the characters. The paper, thus properly prepared, yields easily to the printing press, and takes a sufficient quantity of ink. The stuff must be without grease, and wrought with that degree of slowness as to make it spread equally over the form, and take a neat and regular grain; without this, the characters will not be equally marked in every part of the page; and the smallest quantity of grease renders the sizing unequal and imperfect. Some artists, with considerable success, both to meliorate the grain, and to reduce the inequalities of the surface, have submitted this paper to the exchange. And it is proper to add, that a moderate degree of exchanging and pressing may be of great service after the sheets are printed, to destroy the hollow places occasioned by the press, and the relievo of the letters. Engraving requires a paper of the same qualities with the last mentioned, with respect to the stuff, which must be pure, without knots, and equally reduced; the grain uniform, and the sheets without folds or wrinkles. To preserve the grain, it is necessary that it be dried slowly in the lowest place of the drying house. If it is submitted to the exchange, the effects of it must be moderated with the greatest care, and the action of the two first presses must be equally distributed over the whole mass, otherwise the inequality of the moisture at the middle and sides will expose it to wrinkles in the drying. The sizing of this paper must also be moderate These circumstances are necessary to make it receive with neatness all the soft and delicate touches of the plate. The soft and yielding paper of Auvergne possesses all those advantages; and accordingly, a great quantity of this, and of printing paper, were formerly imported into Britain and Holland from France, where they still continue to rot the materials from which they make engraving paper.

The wire-wove frame is peculiarly adapted to this kind of paper. Paper for cards must be manufactured from a pretty firm stuff, in order to take that degree of smoothness which makes the cards glide easily over one another in using. For this reason the card-makers reject every kind of paper which is soft and

without strength. This paper requires to be very much sized, since the sizing holds the place of varnish, to which the smoothing gives a glazed and shining surface. To answer all these purposes, the rags require to be a little rotted, and the mallets strongly armed with iron studs.

There are three methods by which paper-hangings are painted; the first by printing on the colours; the second by using the stencil; and the third by laying them on with a pencil, as in other kinds of painting. When the colours are laid on by printing, the impression is made by wooden prints, which are cut in such a manner, that the figure to be expressed is made to project from the surface by cutting away all the other part; and this, being charged with the colours tempered with their proper vehicle, by letting it gently down on the block on which the colour is previously spread, conveys it from thence to the ground of the paper, on which it is made to fall more forcibly by means of its weight, and the effort of the arm of the person who uses the print. It is easy to conclude, that there must be as many separate prints as there are colours to be printed But where there are more than one, great care must be taken, after the first, to let the print fall exactly in the same part of the paper as that which went before; otherwise the figure of the design would be brought into irregularity and confusion. In common paper of low price, it is usual, therefore, to print only the outlines, and lay on the rest of the colours by stencilling, which both saves the expense of cutting more prints, and can be practised by common workmen, not requiring the great care and dexterity necessary to the using several prints. The manner of stencilling the colours is this: the figure, which all the parts of any particular colour make in the design to be painted, is to be cut out in a piece of thin leather, or oil-cloth, which pieces of leather, or oil-cloth, are called stencils; and being laid flat on the sheets of paper to be printed, spread on a table or floor, are to be rubbed over with the colour, properly tempered, by means of a large brush. The colour passing over the whole is consequently spread on those parts of the paper where the cloth or leather is cut away, and give the same effect as if laid on by a print. This is nevertheless only practicable in parts where there are only detached masses or spots of colours; for where there are small continued lines, or parts that run one into another, it is difficult to preserve the connection or continuity of the parts of the cloth, or to keep the smaller corners close down to the paper; and therefore, in such cases, prints are preferable. Stencilling is indeed a cheaper method of ridding coarse work than printing; but without such extraordinary attention and trouble, as render it equally difficult with printing, it is far less beautiful and exact in the effect. For the outline of the spots of colour want that sharpness and regularity that are given by prints, besides the frequent extra lineations, or deviations from the just figure, which happens by the original misplacing of the stencils, or the shifting the place of them during the operation. Pencilling is only used in the case of nicer work, such as the better imitations of the India paper. It is performed in the same manner as other paintings in water or varnish. It is sometimes used only to fill the outlines already formed by printing, where the price of the colour, or the exactness of the manner in which it is required to be laid on, render the stencilling or printing it less proper; at other times, it is used for forming or delineating some parts of the design, where a spirit of freedom and variety, not to be had in printed outlines, are desired to be had in the work. The paper designed for receiving the flock is first prepared with a varnish-ground with some proper colour, or by that of the paper itself. is frequently practised to print some Mosaic, or other small running figure in colours, on the ground, before the flock be laid on; and it may be done with any pigment of the colour desired, tempered with varnish, and laid on by a print cut correspondently to that end. The method of laying on the flock is this: a wooden print being cut, as is above described, for laying on the colour in such manner that the part of the design which is intended for the flock may project beyond the rest of the surface, the varnish is put on a block covered with leather or oil-cloth, and the print is to be used also in the same manner, to lay the varnish on all the parts where the flock is to be fixed. The sheet thus prepared by the varnished impression, is then to be removed to another block or table, and to be strewed over with flock, which is afterwards to be gently compressed by a board, or some other flat body, to make the varnish take the better hold of it; and then the sheet is to be hung on a frame till the varnish be perfectly dry, at which time the superfluous part of flock is to be brushed off

by a soft camel's-hair brush, and the proper flock will be found to adhere in a strong manner. The method of preparing the flock is, by cutting woollen rags or pieces of cloth with the hand, by means of a large bill or chopping-knife; or by means of a machine worked by a horse-mill. There is a kind of counterfeit flock-paper, which, when well managed, has very much the same effect to the eye as the real, though done with less expense. The manner of making this sort is, by laying a ground of varnish on the paper; and having afterwards printed the design of the flock in varnish, in the same manner as for the true; instead of the flock, some pigment, or dry colour, of the same hue with the flock required by the design, but somewhat of a darker shade, being well powdered, is strewed on the printed varnish, and produces nearly the same appearance.

Paper, *blotting*, is paper not sized, and into which ink readily sinks: it is used in books, &c. instead of sand, to prevent blotting; and also by apothecaries for filtering.

PAPIER *mache.* This is a substance made of cuttings of white or brown paper, boiled in water, and beaten in a mortar till they are reduced into a kind of paste, and then boiled with a solution of gum arabic or of size, to give tenacity to the paste, which is afterwards formed into different toys, &c. by pressing it into oiled moulds. When dry, it is done over with a mixture of size and lamp-black, and afterwards varnished. The black varnish for these toys, according to Dr. Lewis, is prepared as follows. Some colophony, or turpentine, boiled down till it becomes black and friable, is melted in a glazed earthen vessel, and thrice as much amber in fine powder sprinkled in by degrees, with the addition of a little spirit or oil of turpentine now and then: when the amber is melted, sprinkle in the same quantity of sarcocolla, continuing to stir them, and to add more spirit of turpentine, till the whole becomes fluid; then strain out the clear through a coarse hair bag, pressing it gently between hot boards. This varnish, mixed with ivory-black in fine powder, is applied in a hot room on the dried paper paste, which is then set in a gently heated oven, next day in a hotter oven, and the third day in a very hot one, and let stand each time till the oven grows cold.

PAPILIO, in natural history, *butterfly*, a genus of insects of the order Lepidoptera: antennæ growing thicker towards the tip, and generally ending in a knob; wings when fitting erect, the backs meeting together over the abdomen; they fly in the day-time. The number of species under this genus (not less than 1200) renders it necessary to divide the whole into sections, which are instituted from the habit or general appearance, and, in some degree, from the distribution of the colour on the wings. We shall give the arrangement according to Linnæus, which in this instance exhibits an attempt to combine, in some degree, natural and civil history, by attaching the memory of some illustrious ancient name to an insect of a particular cast. By this plan there are five divisions, *viz.*

1. *Equites*: upper wings longer from the posterior angle to the tip than to the base; antennæ frequently filiform. The Equites are, Trojans, having red spots or patches on each side their breasts; or Greeks, without red marks on the breast, of gayer colours, in general, than the former, and often having an eye-shaped spot at the inner corner of the lower wings.

2. *Heliconii*: wings narrow, entire, often naked, or semi-transparent; the upper ones oblong, the lower ones very short. In some of the Heliconii the under wings are slightly indented.

3. *Danai*, from the sons and daughters of Danaus. These are divided into D. candidi and D. festivi; the wings of the former are white, of the latter they are variegated.

4. *Nymphales*: wings denticulate. Of these there are the gemmati and the phalerati; the one having eye-shaped spots either on all the wings, or on the upper or lower pair only; the others have no spots on their wings, but, in general, a great variety of colours.

5. *Plebeii*: small; the larva often contracted. These are divided into the rurales, wings with obscure spots; and the urbicolæ, wings mostly with transparent spots.

Among the Equites Troes, the P. Priamus should take the lead, not only from the corresponding dignity of the name, but from the exquisite appearance of the animal itself, which Linnæus considered as the most beautiful of the whole papilionaceous tribe. This admirable species measures more than six inches from wing's end to wing's end: the upper wings are velvet-black, with a broad band of the most beautiful grass-green, and of a satiny lustre, drawn from the shoulder to the tip, and another on the

lower part of the wing, following the shape of that part, and of a somewhat undulating appearance as it approaches the tip: the lower wings are of the same green colour, edged with velvet-black, and marked by four spots of that colour; while at the upper part of each, or at the part where the upper wings lap over, is a squarish orange-coloured spot: the thorax is black, with sprinklings of lucid green in the middle, and the abdomen is of a bright yellow or gold colour. On the under side of the animal the distribution of colours is somewhat different, the green being disposed in central patches on the upper wings, and the lower being marked by more numerous black as well as orange spots. The red or bloody spots on each side of the thorax are not always to be seen on this, the Trojan monarch. The P. Priamus is a very rare insect, and is a native of the island of Amboyna.

P. Philenor: wings tailed black, margin of the upper ones varied with white and black; lower ones glossed with green, seven fulvous spots beneath, each surrounded by a black line and marked with a small white lateral dot. Body black; breast and abdomen spotted with white. Not uncommon in the United States.

Among the Equites Achivi, the P. Menelaus may be considered as one of the most splendidly beautiful of the butterfly tribe. Its size is large, measuring when expanded about six inches; and its colour is the most brilliant silver-blue that imagination can conceive, changing, according to the variation of the light, into a deeper blue, and in some lights to a greenish cast: on the under side it is entirely brown, with numerous deeper and lighter undulations, and three large ocellated spots on each wing. It is a native of South America, and proceeds from a large yellow caterpillar, beset with numerous, upright, sharp, black spines. It changes into an angular chrysalis, of a brown colour, and distinguished by having the proboscis projecting in a semicircular manner over the breast; from this chrysalis, in about fourteen days, proceeds the complete insect.

The P. Machaon is an insect of great beauty, and may be considered as the only British species of Papilio belonging to the tribe of Equites. It is commonly known among the English collectors by the title of the swallow-tailed butterfly, and is of a beautiful yellow, with black spots or patches along the upper edge of the superior wings: all the wings are bordered with a deep edging of black, decorated with a double row of crescent-shaped spots, of which the upper row is blue, and the lower yellow: the under wings are tailed, and are marked at the inner angle or tip with a round red spot bordered with blue and black. The caterpillar of this species feeds principally on fennel, and other umbelliferous plants, and is sometimes found on rue. It is of a green colour, encircled with numerous black bands, spotted with red, and is furnished on the top of the head with a pair of short tentacula of a red colour, which it occasionally protrudes from that part. In the month of July it changes into a yellowish-grey angular chrysalis, affixed to some convenient part of the plant, or other neighbouring substance, and from this chrysalis in the month of August proceeds the complete insect.

P. Turnus: wings tailed, both surfaces alike, yellow, with a black margin and abbreviated bands; angle of the tail fulvous. It is very common in the United States, and is figured by Cramer under the name of Alcidamas; bears considerable resemblance to the preceding species, but besides other differences it is larger.

Of the division called Heliconii, the beautiful insect, the P. Apollo, is an example. It is a native of many parts of Europe, and is of a white colour, with a semi-transparency towards the tips of the wings, which are decorated with velvet-black spots, and on each of the lower wings are two most beautiful ocellated spots, consisting of a carmine-coloured circle, with a white centre and black exterior border. The caterpillar is black, with small red spots, and a pair of short retractile tentacula in front: it feeds on orpine, and some other succulent plants, and changes into a brown chrysalis, covered with a kind of glaucous or violet-coloured powder.

Of the division entitled Danai Candidi, P. Palæno is a familiar example. The wings entire, yellow with a black tip, fulvous margin, and red fringe on the edge; lower ones with a silvery dot beneath. The antennæ are red. Extremely common in every part of North America, and in many countries of Europe. The larva is a little hairy, green, with yellow lines and black dots.

P. Nicippe: wings entire fulvous, tipt with brown; upper pair with a short black transverse line near the middle of each: lower ones beneath speckled with reddish. Inhabits North America, and is about the size of the preceding.

Among the Nymphales Gemmati, few can exceed in elegance the P. Antiopa, a species that appears in the United States earlier in the season than any other butterfly; it is not unusually seen before the snow has disappeared from the ground; Mr. Wilson alludes to this insect when he says

"When first the lone butterfly flits on the wing."

The wings are angular indented black-brown with a whitish border, behind which is a row of blue spots; it differs somewhat from the European specimens, and may perhaps be a distinct species.

P. Atalanta: wings indented black; upper-pair with a red band and white spots; lower-ones bordered with red behind, in which are black spots. The larvæ are often found on the hop-vines, on thistles, &c. Inhabits North America and Europe.

Of the last division, termed Plebeii, may be adduced as an example a small English butterfly, called P. Malvæ, of a blackish or brown colour, with numerous whitish and semi-transparent spots. To this latter division also belongs a very beautiful exotic species, a native of India, and of a most exquisite lucid blue colour, edged with black, and further ornamented by having each of the lower wings tipped with two narrow, black, tail-shaped processes. It is the P. Marsyas of Linnæus.

The larvæ of butterflies are known by the name of caterpillars, and are extremely various in their forms and colours; some being smooth, others beset with spines; some are observed to protrude from their front, when disturbed, a pair of short tentacula, nearly analogous to those of a snail. A caterpillar, when grown to its full size, retires to a convenient spot, and securing itself properly by a small quantity of silken filaments, either suspends itself by the tail, hanging with its head downwards, or else in an upright position, with the body fastened round the middle by a proper number of filaments. It then casts off the caterpillar skin, and commences chrysalis, in which state it continues till the enclosed butterfly is ready for birth, which, liberating itself from the skin of the chrysalis, remains till its wings, which are at first very short, weak, and covered with moisture, are fully extended: this happens in the space of a few minutes, when the animal suddenly quits the state of inactivity to which it had long been confined, and becomes at pleasure an inhabitant of the air.

PAPILIONACEI, in botany, a term applied to certain flowers, from their supposed resemblance to the figure of a butterfly. The term is applied also to the thirty-second order of Linnæus's "Fragments of a Natural Method." They are divided into two sections; *viz.* those that have the filaments on the stamina distinct, and those with one set of united filaments. These plants, otherwise called leguminous, from the seed-vessel, which is that sort termed a legumen, are very different both in size and duration; some of them being herbaceous, and those either annual or perennial; others, woody vegetables of the shrub and tree kind, a few of which rise to the height of seventy feet, and upwards. The herbaceous plants of this order generally climb; for being weak, and as it were helpless of themselves, indulgent nature has either provided them with tendrils, and even sharp-pointed hooks at their extremities, to fasten upon the neighbouring trees or rocks, or endued the stalks with a faculty of twisting themselves for the purpose of support around the bodies in their neighbourhood. The pea, vetch, and kidney-bean, afford familiar examples of the appearances in question. The shrubs and trees of this natural family are mostly armed with strong spines. The roots are very long, and furnished with fibres: some genera have fleshy tubercles, placed at proper intervals along the fibres. The stems are cylindric, as are likewise the young branches, which are placed alternately: those which climb twist themselves from right to left, in a direction opposite to the apparent diurnal motion of the sun. The bark of the large trees is extremely thick and wrinkled, so as to resemble a net with long meshes; the wood is very hard in the middle, and commonly coloured or veined; the alburnum is less hard, and generally of a yellow colour. The buds are hemispherical, without scales, and proceed from the branches horizontally, a little above the angle which they form with the leaves. The leaves are alternate, and of different forms, being either

simple, finger-shaped, or winged. The flowers are hermaphrodite, and proceed either from the wings of the leaves, as in furze, liquorice, lupin, kidney-bean, &c. or from the extremity of the branches, as in ebony of Crete, false acacia, trefoil, coral-tree, &c. The calyx is a perianthium of one leaf, bell-shaped, branching out at the bottom, and cut on its brim or margin into five irregular divisions, or teeth, the lowermost of which being the odd one, is longer than the rest: the other four stand in pairs, of which the uppermost is shortest, and stands furthest asunder. The bottom of the calyx is moistened with a sweet liquor, like honey, which may be deemed the nectarium of these plants. The petals are four or five in number, very irregular, and from their figure and position bear an obvious resemblance in most of the genera to a butterfly expanding its wings for flight. The stamina are generally ten in number. These are either totally distinct, as in plants of the first section; or united by the filaments into one or two bundles, involving the seed bud, as in those of the second and third. In the latter case, where there are two sets of united filaments, one of the sets is composed of nine stamina, which are united into a crooked cylinder, that is cleft on one side through its whole length. Along this cleft lies the tenth filament, or stamen, which constitutes the second set, and is often so closely attached to the large bundle, that it cannot be separated without some difficulty. The seed-bud is single, placed upon the receptacle of the flower, oblong, cylindrical, slightly compressed, of the length of the cylinder of the united stamina by which it is involved; and sometimes, as in the coral-tree, elevated by a slender foot-stalk, which issues from the centre of the calyx. The style is single, slender, and generally crooked. In the pea the style is hairy, three-cornered, and keel-shaped above; by which last circumstance chiefly that genus is distinguished from the lathyrus, in which the style is plain. The stigma, or summit of the style, is generally covered with a beautiful down, and placed immediately under the anthers, or tops of the stamina. The seed-vessel in this order is that sort of pod termed a legumen, which is of an oblong figure, more or less compressed, with two valves, and one, two, or more cavities; these cavities are often separated, when ripe, by a sort of joints, which are conspicuous in the pods of the coronilla, French honey-suckle, horse-shoe vetch, bird's-foot, bastard sensitive-plant, and scorpiurus: the seeds are generally few in number, round, smooth, and fleshy. Jointed pods have generally a single seed in each articulation. The seeds are all fastened along one suture, and not alternately to both, as in the other species of pod termed siliqua.

The plants of this family are in general mucilaginous; from the inner bark flows a clammy liquor, which dries and hardens like gum: the juice of others, as that of the liquorice, is sweet like sugar. Some of the plants are bitter, purgative, or emetic, and some are poisonous. They are, however, emollient, useful in the healing of wounds, and astringent. See Milne's Botanical Dictionary.

PAPISTS, persons professing the Popish religion. By several statutes, if any English priest of the church of Rome, born in the dominions of the crown of England, came from beyond the seas, or tarried in England three days without conforming to the church, he was guilty of high treason; and they also incurred the guilt of high treason who were reconciled to the see of Rome, or procured others to be reconciled to it. By these laws, also, Papists were disabled from giving their children education in their own religion. If they educated their children at home, for maintaining the schoolmaster, if he did not repair to the church, or was not allowed by the bishop of the diocese, they were liable to forfeit 10*l.* a month, and the schoolmaster was liable to the forfeiture of 40*s.* a day. If they sent their children for education abroad, they were liable to forfeit 100*l.* and the children so sent were incapable of inheriting, purchasing, or enjoying any lands, profits, goods, debts, legacies, or sums of money: saying mass was punishable by a forfeiture of 200 marks; and hearing it, by a forfeiture of 100*l.*

By statute 11 and 12 William III. c. 4, the Chancellor may take care of the education and maintenance of the protestant children of papists.

By the laws against recusancy, all persons abstaining from going to church were liable to penalties. By 35 Elizabeth, c. 2, a distinction was made against Papists, who, if convicted of recusancy, were fined 20*l.* per month, disabled from holding offices, keeping arms in their houses, suing at law, being executors and guardians, presenting to advowsons, practising law or physic; from holding offices civil or military; were subject to excommunication; could not travel five miles from home, nor come to court, un-

der pain of 100*l.* Marriages and burials of Papists were to be according to the rites of the Church of England. A married woman convicted of recusancy lost two-thirds of her dower; she could not be executrix to her husband; might be kept in prison during marriage, unless her husband paid 10*l.* per month, or gave the third part of his lands. Popish recusants convict were, within three months after conviction, either to submit, and renounce their religious opinions, or to abjure the realm, if required by four justices; and if they did not depart, or returned without license, were guilty of capital felony; so that abjuration was transportation for life.

But during the present reign the Roman Catholics have been in a great measure relieved from the odious and severe (if not unjust) restrictions formerly imposed on them, by the statutes 18 George III. c. 60, and 31 George III. c. 22, to which, on account of their length and consequence, the reader is referred. The principal effects of these statutes are to repeal the 11 and 12 William III. c. 4, as to prosecuting Popish priests, &c. and to disable Papists from taking lands by descent or purchase: if they take the oath expressing allegiance to the King, abjuring the Pretender, renouncing the Pope's civil power, and abhorring the doctrine of not keeping faith with heretics, and of deposing or murdering princes excommunicated by the see of Rome. The statute 31 George III. c. 32, has afforded them the most effectual relief, and consists of six parts. The first contains the oath and declaration to be taken; the second is a repeal of the statutes of recusancy in favour of persons taking that oath; the third is a toleration, under certain regulations, of the religious worship of the Catholics, qualifying in like manner, and of their schools for education; the fourth enacts, that no one shall be summoned to take the oath of supremacy prescribed by statutes 1 William and Mary, st. 1. c. 8; 1 George I. st. 2. c. 13; or the declaration against transubstantiation required by statute 25 Charles II. c. 2; that the statute 1 William and Mary, st. 1. c. 9, for removing Papists, or reputed Papists, from the cities of London and Westminster, shall not extend to Roman Catholics taking the appointed oath; and that no peer of Great Britain or Ireland, taking that oath, shall be liable to be prosecuted for coming into his Majesty's presence, or into the court or house where his Majesty resides, under statute 30 Charles II. st. 2, c. 1. The fifth part of the act repeals the laws requiring the deeds and wills of Roman Catholics to be registered or enrolled; the sixth excuses persons acting as counsellors at law, barristers, attornies, clerks, or notaries, from taking the oath of supremacy, or the declaration against transubstantiation. But it is adviseable to take the oath of 18 George III. 30, to prevent all doubts, or ability to take by descent or purchase.

As the statute 1 William and Mary, st. 1, c. 18, called the Toleration Act, does not apply to Catholics, or persons denying the Trinity, they cannot serve in corporations, and are liable to the test and corporation act. They cannot sit in the House of Commons, nor vote at elections, without taking the oath of supremacy; and cannot present to advowsons, although Jews and Quakers may. But the person is only disabled from presenting, and still continues patron. It seems they may serve on juries, but Catholic ministers are exempted. They also are entitled to attend the British factories and their meetings abroad, and may hold offices to be wholly exercised abroad, and may also serve under the East India Company, or in the army abroad, and the sixtieth regiment is chiefly composed of persons who cannot serve in England, by reason of the officers being many of them Catholics. This account of the state of the laws against Papists is extracted from an able review of them given by Mr. Butler, a Roman Catholic, in his Notes upon Lord Coke's Commentary on Littleton's Tenures, and which is to be found also in Tomlin's Law Dictionary, last edition, title PAPIST.

PAPPOPHORUM, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina, or Grasses, Essential character: calyx two-valved, two-flowered; corolla two-valved, many awned. There is but one species; *viz.* P. alopecuroideum, a native of Spanish Town in America.

PAPPUS, in botany, *thistle-down,* a sort of feathery or hairy crown, with which many seeds, particularly those of compound flowers, are furnished, for the purpose of dissemination. A seed surmounted by its pappus resembles a shuttle-cock, so that it is naturally framed for flying, and for being transported by the wind to very considerable distances from its parent plant. By this contrivance of nature, the dandelion, ground-

sel, &c. are disseminated far and wide. In some plants, as hawk-weed, the pappus adheres immediately to the seed; in others, as lettuce, it is elevated upon a foot-stalk, which connects it with the seeds. In the first case it is called pappus sessilis; in the second, pappus stipitatus: the foot-stalk, or thread, upon which it is raised is termed "stipes."

PAR, in commerce, signifies any two things equal in value; and in money affairs, it is so much as a person must give of one kind of specie to render it just equivalent to a certain quantity of another. In the exchange of money with foreign countries, the person to whom a bill is payable is supposed to receive the same value as was paid the drawer by the remitter; but this is not always the case, with respect to the intrinsic value of the coins of different countries, which is owing to the fluctuation in the prices of exchange amongst the several European countries, and the great trading cities. The par, therefore, differs from the course of exchange in this, that the par of exchange shews what other nations should allow in exchange, which is rendered certain and fixed by the intrinsic value of the several species to be exchanged: but the course shews what they will allow in exchange; which is uncertain and contingent, sometimes more, and sometimes less; and hence the exchange is sometimes above, and sometimes under par. See EXCHANGE.

PARABOLA, in geometry, a figure arising from the section of a cone, when cut by a plane parallel to one of its sides. See CONIC SECTIONS.

To describe a parabola in plano, draw a right line A B (Plate Parabola, fig. 1) and assume a point C without it; then, in the same plane with this line and point, place a square rule D E F, so that the side D E may be applied to the right line A B, and the other E F turned to the side on which the point C is situated. This done, and the thread F G C, exactly of the length of the side of the rule, E F, being fixed at one end to the extremity of the rule F, and at the other to the point C, if you slide the side of the rule, D E, along the right line A B, and by means of a pin, G, continually apply the thread to the side of the rule, E F, so as to keep it always stretched as the rule is moved along, the point of this pin will describe a parabola G H O.

Definitions. 1. The right line A B is called the directrix. 2. The point C is the focus of the parabola. 3. All perpendiculars to the directrix, as L K, M O, &c. are called diameters; the points, where these cut the parabola, are called its vertices; the diameter B I, which passes through the focus C, is called the axis of the parabola; and its vertex, H, the principal vertex. 4. A right line, terminated on each side by the parabola, and bisected by a diameter, is called the ordinate applicate, or simply the ordinate, to that diameter. 5. A line equal to four times the segment of any diameter, intercepted between the directrix and the vertex where it cuts the parabola, is called the latus rectum, or parameter of that diameter. 6. A right line which touches the parabola only in one point, and being produced on each side falls without it, is a tangent to it in that point.

Prop. 1. Any right line, as G E, drawn from any point of the parabola, G, perpendicular to A B, is equal to a line, G C, drawn from the same point to the focus. This is evident from the description; for the length of the thread, F G C, being equal to the side of the rule E F, if the part F G, common to both, be taken away, there remains E G = G C. Q. E. D.

The reverse of this proposition is equally evident, *viz.* that if the distance of any point from the focus of a parabola be equal to the perpendicular drawn from it to the directrix, then shall that point fall in the curve of the parabola.

Prop. 2. If from a point of the parabola, D, (fig. 2) a right line be drawn to the focus, C; and another D A, perpendicular to the directrix; then shall the right line, D E, which bisects the angle, A D C, contained between them, be a tangent to the parabola in the point D: a line also, as H K, drawn through the vertex of the axis, and perpendicular to it, is a tangent to the parabola in that point.

1. Let any point F, be taken in the line D E, and let F A, F C, and A C be joined; also let F G be drawn perpendicular to the directrix. Then, because (by Prop. 1), D A = D C, D F common to both, and the angle F D A = F D C, F C will be equal to F A; but F A greater than F G, therefore F C greater than F G, and consequently the point, F, falls without the parabola: and as the same can be demonstrated of every other point of D E, except D, it follows that D E is a tangent to the parabola in D. Q. E. D.

2. If every point of H K, except H, falls without the parabola, then is H K a tangent in H. To demonstrate this, from any point K, draw K L perpendicular to A B, and join K C; then because K C is

greater than C H = H B = K L, it follows that K C is greater than K L, and consequently that the point K falls without the parabola: and as this holds of every other point, except H, it follows that K H is a tangent to the parabola in H. Q. E. D.

Prop. 3. Every right line, parallel to a tangent, and terminated on each side by the parabola, is bisected by the diameter passing through the point of contact: that is, it will be an ordinate to that diameter. For let E *e* (fig. 3 and 4) terminating in the parabola in the points E *e*, be parallel to the tangent D K; and let A D be a diameter passing through the point of contact D, and meeting E *e* in L; then shall E L = L *e*.

Let A D meet the directrix in A, and from the points E *e*, let perpendiculars E F, *e f*, be drawn to the directrix; let C A be drawn, meeting E *e* in G; and on the centre E, with the distance E C, let a circle be described, meeting A C again in H, and touching the directrix in F; and let D C be joined. Then because D A = D C, and the angle A D K = the angle C D K, it follows (4. 1) that D K perpendicular to A C; wherefore E *e* perpendicular to A C, and C G = G H (3. 3); so that *e* C = *e* H (4. 1), and a circle described upon the centre *e* with the radius *e* C, must pass through H; and because *e* C = *e f*, it must likewise pass through *f*. Now because F *f* is a tangent to both these circles, and A H C cuts them, the square A F = the rectangle C A H (36. 3) = the square A *f*; therefore A F = A *f*, and F E, A L, and *f e* are parallel; and consequently L E = L *e*. Q. E. D.

Prop. 4. If from any point of a parabola, D, (fig. 5) a perpendicular, D H, be drawn to a diameter B H, so as to be an ordinate to it; then shall the square of the perpendicular, DH^2, be equal to the rectangle contained under the absciss H F, and the parameter of the axis, or to four times the rectangle H F B.

1. When the diameter is the axis; let D H be perpendicular B C, join D C, and draw D A perpendicular A B, and let F be the vertex of the axis. Then, because H B = D A = D C, it follows that $HB^2 = DC^2 = DH^2 + HC^2$. Likewise, because B F = F C, $HB^2 = 4$ times the rectangle H F C + HC^2 (by 8. 2). Wherefore $DH^2 + HC^2 = 4$ times the rectangle H F B + HC^2; and $DH^2 = 4$ times the rectangle H F B; that is, $DH^2 =$ the rectangle contained under the absciss H F, and the parameter of the axis.

2. When the diameter is not the axis: let E N (fig. 3 and 4) be drawn perpendicular to the diameter A D, and E L an ordinate to it; and let D be the vertex of the diameter.

Then shall $EN^2 =$ to the rectangle contained under the absciss, L D, and the parameter of the axis. For let D K be drawn parallel to L E, and consequently a tangent to the parabola in the point D; and let it meet the axis in K: let E F be perpendicular A B the directrix; and on the centre E, with the radius E F, describe a circle, which will touch the directrix in F, and pass through the focus C: then join A C, which will meet the circle again in H, and the right lines D K, L E, in the points P G; and, finally, let L E meet the axis in O.

Now since the angles C P K, C B A are right, and the angle B C P common, the triangles C B A, C P K are equiangular; and A C : C B (or C K : C P) : : O K : G P; and A C × G P = O K × C B. Again, because C A = 2 C P, and C H = 2 C G, A H = 2 G P; and consequently the rectangle C A H = $\overline{CA \times 2GP}$ = $\overline{OK \times 2CB}$. But, $EN^2 = FA^2 =$ rectangle C A H; and consequently, $EN^2 = \overline{OK \times 2CB} =$ the rectangle contained under the absciss, L D, and the parameter of the axis. Q. E. D.

Hence, 1. The squares of the perpendiculars, drawn from any points of the parabola to any diameters, are to one another as the abscissæ intercepted between the vertices of the diameters and the ordinates applied to them from the same points.

2. The squares of the ordinates, applied to the same diameter, are to each other as the abscissæ between each of them and the vertex of the diameter. For let E L, Q R be ordinates to the same diameter D N; and let E N, Q S be perpendiculars to it. Then, on account of the equiangular triangles E L N, Q R S, $EL^2 : QR^2 : : EN^2 : QS^2$: that is, as the absciss D L to the absciss D R.

Prop. 5. If from any point of a parabola E (fig. 3 and 4), an ordinate, E L, be applied to the diameter A D; then shall the square of E L be equal to the rectangle contained under the absciss D L, and the latus rectum or parameter of that diameter.

For since Q R = D K, QR^2 will be equal to $DM^2 + MK^2$; but (by case 1. of Prop. 4), $DM^2 = 4$ times the rectangle M Q B; and because M Q = Q K, $MK^2 = 4\,MQ^2$: wherefore $QR^2 = 4$

times the rectangle M Q B + 4 M Q^2; that is, to 4 times the rectangle Q M B. But M Q = Q K = D R, and M B = D A; wherefore Q R^2 = 4 times the rectangle R D A: and because Q R, E L are ordinates to the diameter A D, Q R^2 (by cor. 2, of Prop. 4), : E L^2 (: R D : L D) : : 4 times the rectangle R D A : 4 times the rectangle L D A. Therefore E L^2 = 4 times the rectangle L D A, or the rectangle contained under the absciss L D, and the parameter of the diameter A D: and from this property Apollonius called the curve a parabola. Q. E. D.

Prop. 6. If from any point of a parabola, A. (fig. 6) there be drawn an ordinate, A C, to the diameter B C; and a tangent to the parabola in A, meeting the diameter in D: then shall the segment of the diameter, C D, intercepted between the ordinate and the tangent, be bisected in the vertex of the diameter B. For let B E be drawn parallel to A D, it will be an ordinate to the diameter A E; and the absciss B C will be equal to the absciss A E, or B D. Q. E. D.

Hence, if A C be an ordinate to B C, and A D be drawn so as to make B D = D C, then is AD a tangent to the parabola. Also the segment of the tangent, A D, intercepted between the diameter and point of contact, is bisected by a tangent B G, passing through the vertex of D C.

"To draw Tangents to the Parabola." If the point of contact C be given: (fig. 7) draw the ordinate C B, and produce the axis till A T be = A B; then join T C, which will be the tangent. Or if the point be given in the axis produced: take A B = A T, and draw the ordinate B C, which will give C the point of contact; to which draw the line T C as before. If D be any other point, neither in the curve nor in the axis produced, through which the tangent is to pass: draw D E G perpendicular to the axis, and take D H a mean proportional between D E and D G, and draw H C parallel to the axis, so shall C be the point of contact through which, and the given point D, the tangent D C T is to be drawn.

When the tangent is to make a given angle with the ordinate at the point of contact: take the absciss A I equal to half the parameter, or to double the focal distance, and draw the ordinate I E: also draw A H to make with A I the angle H A I equal to the given angle; then draw H C parallel to the axis, and it will cut the curve in C, the point of contact, where a line drawn to make the given angle with C B will be the tangent required.

"To find the Area of a Parabola." Multiply the base E G by the perpendicular height A I, and $\frac{2}{3}$ of the product will be the area of the space A E G A; because the parabolic space is $\frac{2}{3}$ of its circumscribing parallelogram.

"To find the Length of the Curve A C," commencing at the vertex. Let y = the ordinate B C, p = the parameter, $q = \frac{2y}{p}$, and $s = \sqrt{1 + q^2}$; then shall $\frac{1}{2} p \times (q\,s +$ hyp. log. of $q + s)$ be the length of the curve A C.

Parabola, *Cartesian*, is a curve of the second order, expressed by the equation $x\,y = a\,x^3 + b\,x^2 + c\,x + d$, containing four infinite legs, *viz.* two hyperbolic ones, M M, B m, (Plate Parabola, fig. 8), (A E being the asymptote) tending contrary ways, and two parabolic legs B N, M N joining them, being the sixty-sixth species of lines of the third order, according to Sir Isaac Newton, called by him a trident: it is made use of by Des Cartes, in the third book of his Geometry, for finding the roots of equations of six dimensions by its intersections with a circle. Its most simple equation is $x\,y = x^3 + a^3$, and the points through which it is to pass, may be easily found by means of a common parabola, whose absciss is $a\,x^2 + b\,x + c$, and an hyperbola, whose absciss is $\frac{d}{x}$; for y will be equal to the sum or difference of the correspondent ordinates of this parabola and hyperbola.

Parabola, *diverging*, a name given by Sir Isaac Newton to five different lines of the third order, expressed by the equation $y\,y = a\,x^3 + b\,x^2 + c\,x + d$.

PARABOLIC *asymptote*, in geometry, is used for a parabolic line approaching to a curve, so that they never meet; yet, by producing both indefinitely, their distance from each other becomes less than any given line. Maclaurin observes, that there may be as many different kinds of these asymptotes as there are parabolas of different orders.

When a curve has a common parabola for its asymptote, the ratio of the subtangent to the absciss approaches continually to the ratio of two to one, when the axis of the parabola coincides with the base; but this ratio of the subtangent to the absciss approaches to that of one to two, when the axis is perpendicular to the base. And by observing the limit to which the ratio of the subtangent

and absciss approaches, parabolic asymptotes of various kinds may be discovered.

PARABOLIC *conoid*, in geometry, a solid generated by the rotation of a parabola about its axis: its solidity is $= \frac{1}{2}$ of that of its circumscribing cylinder. The circles, conceived to be the elements of this figure, are in arithmetical proportion, decreasing towards the vertex. A parobolic conoid is to a cylinder of the same base and height, as 1 to 2, and to a cone of the same base and height as $1\frac{1}{2}$ to 1. See the article GUAGING.

PARABOLIC *cuneus*, a solid figure formed by multiplying all the D B's (Plate Parabola, fig. 9) into the D S's; or, which amounts to the same, on the base A P B erect a prism, whose altitude is A S; this will be a parabolical cuneus, which of necessity will be equal to the parabolical pyramidoid, as the component rectangles in one are severally equal to all the component squares in the other.

PARABOLIC *pyramidoid*, a solid figure generated by supposing all the squares of the ordinate applicates in the parabola so placed, as that the axis shall pass through all the centres at right angles; in which case, the aggregate of the planes will form the parabolic pyramidoid.

The solidity hereof is had by multiplying the base by half the altitude, the reason of which is obvious; for the component planes being a series of arithmetical proportionals beginning from 0, their sum will be equal to the extremes multiplied by half the number of terms.

PARABOLIC *space*, the area contained between any entire ordinate as V V (Plate Parabola, fig. 10), and the curve of the incumbent parabola.

The parabolic space is to the rectangle of the semi-ordinate into the absciss, as 2 to 3; to a triangle inscribed on the ordinate as a base, it is as 4 to 3.

Every parabolical and paraboloidical space is to the rectangle of the semi-ordinate into the absciss, as $r\,x\,y\,(m + r)$ to $x\,y$; that is, as r to $m + r$.

PARABOLIC *spindle*, in guaging; a cask of the second variety is called the middle frustrum of a parabolic spindle. The parabolic spindle is eight fifteenths of its circumscribing cylinder.

PARADE, in war, is a place where the troops meet to go upon guard, or any other service. In a garrison where there are two, three, or more regiments, each have their parade appointed, where they are to meet upon all occasions, especially upon any alarm. And in a camp, all parties, convoys, and detachments, have a parading place appointed them at the head of some regiment.

PARADISEA, the *bird of Paradise*, in natural history, a genus of birds of the order Picæ. Generic character: bill covered at the base with downy feathers; nostrils covered by the feathers; tail of ten feathers, two of them, in some species, very long; legs and feet very large and strong. These birds chiefly inhabit North Guinea, from which they migrate in the dry season into the neighbouring islands. They are used in these countries as ornaments for the head-dress, and the Japanese, Chinese, and Persians, import them for the same purpose. The rich and great among the latter attach these brilliant collections of plumage, not only to their own turbans, but to the housings and harnesses of their horses. They are found only within a few degrees of the equator. Gmelin enumerates twelve species, and Latham eight. P. apoda, or the greater Paradise bird, is about as large as a thrush. These birds are supposed to breed in North Guinea, whence they migrate into Aroo, returning to North Guinea with the wet monsoon. They pass in flights of thirty or forty, headed by one whose flight is higher than that of the rest. They are often distressed by means of their long feathers in sudden shiftings of the wind, and unable to proceed in their flight; are easily taken by the natives, who also catch them with birdlime, and shoot them with blunted arrows. They are sold at Aroo for an iron nail each, and at Banda for half a rixdollar. Their food is not ascertained, and they cannot be kept alive in confinement. The smaller bird of Paradise is supposed by Latham to be a mere variety of the above. It is found only in the Papuan islands, where it is caught by the natives often by the hand, and exenterated and seared with a hot iron in the inside, and then put into the hollow of a bamboo to secure its plumage from injury.

PARADOX, in philosophy, a proposition seemingly absurd, as being contrary to some received opinion; but yet true in fact. No science abounds more with paradoxes than geometry; thus, that a right line should continually approach to the hyperbola, and yet never reach it, is a true paradox; and in the same manner, a spiral may continually approach to a point, and yet not reach it, in any number of revolutions, however great.

PARAGOGE, in grammar, a figure

whereby a letter or syllable is added to the end of a word; as *med*, for *me*; *dicier*, for *dici*, &c.

PARALLACTIC, in general, something relating to the parallax of heavenly bodies. See PARALLAX.

The parallactic angle, of a star, &c. is the difference of the angles C E A (Plate Parabola, &c. fig. 11) B T A, under which its true and apparent distance from the zenith is seen; or, which is the same thing, it is the angle T S E. The sines of the parallactic angle A L T, A S T, (fig. 12.) at the same or equal distances, Z S, from the zenith, are in the reciprocal ratio of the distances T L, and T S, from the centre of the earth.

PARALLAX, in astronomy, denotes a change of the apparent place of any heavenly body, caused by being seen from different points of view; or it is the difference between the true and apparent distance of any heavenly body from the zenith. Thus let A B (Plate XII. Miscell. fig. 1.) be a quadrant of a great circle on the earth's surface, A, the place of the spectator, and the point V, in the heavens, the vertex and zenith. Let V N H represent the starry firmament, A D the sensible horizon, in which suppose the star C to be seen, whose distance from the centre of the earth is T C. If this star were observed from the centre T, it would appear in the firmament in E, and elevated above the horizon by the arch D E; this point E is called the true place of the phenomenon or star. But an observer viewing it from the surface of the earth at A, will see it at D, which is called its visible or apparent place; and the arch D E, the distance between the true and visible place, is what astronomers call the parallax of the star, or other phenomenon.

If the star rise higher above the horizon to M, its true place visible from the centre is P, and its apparent place N; whence its parallax will be the arch P N, which is less than the arch D E. The horizontal parallax, therefore, is the greatest; and the higher a star rises, the less is its parallax; and if it should come to the vertex or zenith, it would have no parallax at all; for when it is in Q, it is seen both from T and T and A in the same line T A V, and there is no difference between its true and apparent or visible place. Again, the further a star is distant from the earth, so much the less is its parallax; thus the parallax of the star F is only G D, which is less than D E, the parallax of C. Hence it is plain, that the parallax is the difference of the distances of a star from the zenith, when seen from the centre and from the surface of the earth; for the true distance of the star M from the zenith is the arch V P, and its apparent distance V N, the difference between which, P N, is the parallax.

These distances are measured by the angles V T M, and V A M, but V A M — V T M = T M A. For the external angle V A M = angle A T M + angle A M T, the two inward and opposite angles; so that A M T measures the parallax, and upon that account is itself frequently called the parallax; and this is always the angle under which the semidiameter of the earth, A T, appears to an eye placed in the star; and therefore, where the semi-diameter is seen directly, there the parallax is greatest, *viz.* in the horizon. When the star rises higher, the sine of the parallax is always to the sine of the star's distance from the zenith, as the semi-diameter of the earth to the distance of the star from the earth's centre; hence if the parallax of a star be known at any one distance from the zenith, we can find its parallax at any other distance.

If we have the distance of a star from the earth, we can easily find its parallax; for on the triangle T A C, rectangular at A, having the semi-diameter of the earth, and T C the distance of the star, the angle A C T, which is the horizontal parallax, is found by trigonometry; and, on the other hand, if we have this parallax, we can find the distance of the star; since in the same triangle, having AT, and the angle ACT, the distance TC may be easily found.

Astronomers, therefore, have invented several methods for finding the parallaxes of stars, in order thereby to discover their distances from the earth. However, the fixed stars are so remote as to have no sensible parallax; and even the sun, and all the primary planets, except Mars and Venus when in perigee, are at so great distances from the earth, that their parallax is too small to be observed. In the moon, indeed, the parallax is found to be very considerable, which in the horizon amounts to a degree or more, and may be found thus: in an eclipse of the moon, observe when both its horns are in the same vertical

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circle, and at that instant take the altitudes of both horns: the difference of these two altitudes being halved and added to the least, or subtracted from the greatest, gives nearly the visible or apparent altitude of the moon's centre; and the true altitude is nearly equal to the altitude of the centre of the shadow at that time. Now we know the altitude of the shadow, because we know the place of the sun in the ecliptic, and its depression under the horizon, which is equal to the altitude of the opposite point of the ecliptic in which is the centre of the shadow. And therefore, having both the true altitude of the moon and the apparent altitude, the difference of these is the parallax required. But as the parallax of the moon increases as she approaches towards the earth, or the perigæum of her orbit, therefore astronomers have made tables, which shew the horizontal parallax for every degree of its anomaly.

The parallax always diminishes the altitude of a phenomenon, or makes it appear lower than it would do, if viewed from the centre of the earth; and this change of the altitude may, according to the different situation of the ecliptic and equator in respect of the horizon of the spectator, cause a change of the latitude, longitude, declination, and right ascension of any phenomenon, which is called their parallax. The parallax, therefore, increases the right and oblique ascension; diminishes the descension; diminishes the northern declination and latitude in the eastern part, and increases them in the western; but increases the southern both in the eastern and western part; diminishes the longitude in the western part, and increases it in the eastern. Hence it appears, that the parallax has just opposite effects to refraction. See Refraction.

Parallax, *annual*, the change of the apparent place of a heavenly body, which is caused by being viewed from the earth in different parts of its orbit round the sun. The annual parallax of all the planets is found very considerable, but that of the fixed stars is imperceptible.

Parallax, in levelling, denotes the angle contained between the line of the true level, and that of the apparent level.

PARALLEL. The subject of parallel lines, says Playfair, is one of the most difficult in the Elements of Geometry. It has accordingly been treated in a great variety of different ways, of which, perhaps, there is none which can be said to have given entire satisfaction. The difficulty consists in converting the twenty-seventh and twenty-eighth of Euclid, or in demonstrating, that parallel straight lines (or such as do not meet one another) when they meet a third line, make the alternate angles with it equal, or which comes to the same, are equally inclined to it, and make the exterior angle equal to the interior and opposite. In order to demonstrate this proposition, Euclid assumed it as an axiom, that if a straight line meet two straight lines, so as to make the interior angles on the same side of it less than two right angles, these straight lines being continually produced, will at length meet on the side on which the angles are that are less than two right angles. This proposition, however, is not self-evident; and ought the less to be received, without proof that the converse of it is a proposition that confessedly requires to be demonstrated. In order to remedy this defect, three sorts of methods have been adopted—a new definition of parallel lines; a new manner of reasoning on the properties of straight lines without any new axiom; and the introduction of a new axiom less exceptionable than Euclid's. Playfair adopts the latter plan; but we do not perceive that his axiom is by any means self-evident upon Euclid's definition which he retains, *viz.* Parallel straight lines are such as are in the same plane, and which being produced ever so far both ways do not meet. A more intelligible, and we think an equally rigid, demonstration of the property of parallels, may be obtained without any axiom, by means of a new definition. It may at first sight be thought, that the objection urged by Playfair against the definition in T. Simpson's first edition, must equally hold against ours; but we think that if his objection really hold good against that definition, (though we confess we cannot feel the force of it,) it is obviated by distinguishing, as ought to be done, between the distance and the measure of that distance.

We must of course suppose our readers acquainted with the propositions in Euclid preceding the twenty-seventh; but to save the necessity of reference, we shall give an enunciation of those which we shall have to employ in our demonstration, in the form in which we employ them. 1. (Prop. 16.) If one side of a triangle be produced, the outward angle is greater than either of the inward oppo-

site angles. 2. (Prop. 19.) The greater angle of every triangle has the greater side opposite to it. 3. (Prop. 4.) If two triangles have two sides of the one respectively equal to two sides of the other, and have the included angles equal, the other angles will be respectively equal, *viz.* those to which the equal sides are opposite. 4. (Prop. 15.) If two straight lines cut each other, the vertical or opposite angles will be equal. 5. (Prop. 13.) If a straight line meet another, the sum of the adjacent angles is equal to the sum of two right angles.

6. *Definition.* Parallel straight lines are those whose least distances from each other are every where equal.

7. Theorem I. The perpendicular drawn to a straight line from any point, is the least line that can be drawn from that point to the given line.

Let C D, (Plate XII Miscell. fig. 2) be a straight line drawn from C perpendicular to A B; and let C E be any other straight line from C to A B; then is C D less than C E. For the angle C D E equals angle C D A by construction; and C DA is greater than C E D (1); therefore C DE is greater than C E D. Hence (2) C D is less than C E.

8. Cor. 1. Hence the perpendicular from any point to a straight line is the true measure of the least distance of that point from that line.

9. Cor. 2. Hence (6) the perpendiculars to one of two parallel straight lines, from any points in the other, are every where equal to each other.

10. Cor. 3. Hence two parallel straight lines, however far they may be produced, can never meet.

11. Theorem II. If a line meeting two parallel straight lines be perpendicular to one of them, it is also perpendicular to the other.

If A B, (fig. 3) be parallel to C D, and E F meet them so as to be perpendicular to A B, it will also be perpendicular to C D. If not, draw E G perpendicular to C D, and from G draw G H perpendicular to A B. Then since E F and G H are both perpendicular to A B, and are drawn from F and G points in C D, G H equals E F (9). Again, since angle G H B or G H E is greater than angle G E H (1) E G is greater than G H (2). Hence E G is greater than E F. Therefore E G is not perpendicular to C D (7); and in the same manner it may be shown, that no other line can be drawn from the point E perpendicular to C D without coinciding with E F. Therefore E F is perpendicular to C D.

12. Theorem III. If two straight lines be perpendicular to the same straight line, they are parallel to each other.

If A B, (fig. 4) and C D be both perpendicular to E F, then A B is parallel to C D. If A B be not parallel to C D, let G H, passing through the point E, be parallel to C D. Then since E F is perpendicular to C D, it is also perpendicular to G H (11). Hence angle H E F is a right angle, and therefore equal to angle B E F, the less to the greater, which is absurd. Therefore G H is not parallel to C D; and in the same manner it may be shown that no other line passing through E, and not coinciding with A B, is parallel to C D. Therefore A B is parallel to C D.

13. Cor. Hence it appears, that through the same point no more than one line can be drawn parallel to the same straight line.

It may be thought necessary to remark, that the preceding theorem pre-supposes the admission of a postulate, that through any point, not in a given straight line, a straight line may be drawn parallel to that straight line, or that straight line produced.

14. Theorem IV. If a straight line fall upon two parallel straight lines, it makes the alternate angles equal to one another; and the exterior angle equal to the interior and opposite angle on the same side; and likewise, the two interior angles upon the same side, together, equal to two right angles.

If A B, (fig. 5.) be parallel to C D, and E F cut them in the points H G, then the angle A H G equals the alternate angle H G D; the exterior angle E H B equals the interior and opposite angle on the same side, H G D; and the two interior angles on the same side, B N G; and H G D are together equal to two right angles. From H draw H K perpendicular to C D, and from G draw G I perpendicular to A B. Then since H K is perpendicular to C D, it is also perpendicular to A B (11); consequently G I is parallel to H K (12). But H I and G K are perpendiculars to G I, from H and K, points in H K; therefore (9) H I equals G K. Hence in triangles G I H, H G K, the side H I equals the side G K, G I equals H K (9) and the included angle G I H equals the included angle H K G; therefore angle I H G equals angle H G K (3). Again, angle E H B equals A H G (4); therefore it

equals H G D. Lastly, B N G and H G D are together equal to A H G and B H G together; and therefore (5) are equal together to the sum of two right angles.

15 Theorem V. If a straight line falling upon two other straight lines makes the alternate angles equal to one another, those two straight lines will be parallel.

Let the straight line E F, (fig. 6) which falls upon the two straight lines A B, C D, make the alternate angles A E F, E F D equal to one another, then A B is parallel to C D. If not, through E draw G H parallel to C D. Then the alternate angle G E F equals the alternate angle E F D. But A E F equals E F D; therefore A E F is equal to G E F, the less to the greater. Hence G H is not parallel to C D; and in like manner it may be shown that no other line passing through the point E, and not coinciding with A B, is parallel to C D. Therefore A B is parallel to C D.

16. Cor. If a straight line, falling upon two other straight lines, makes the exterior angle equal to the interior and opposite one on the same side of the line; or makes the interior angles on the same side equal to two right angles; the two straight lines shall be parallel to one another.

Parallel *planes*, are such planes as have all the perpendiculars drawn betwixt them equal to each other.

Parallel *rays*, in optics, are those which keep at an equal distance from the visible object to the eye, which is supposed to be infinitely remote from the object.

Parallel *ruler*, an instrument consisting of two wooden, brass, &c. rulers, equally broad every where; and so joined together by the cross blades as to open to different intervals, accede and recede, and yet still retain their parallelism. See Pentagraph.

Parallels, or *parallel circles*, in geography, called also parallels, or circles of latitude, are lesser circles of the sphere conceived to be drawn from west to east, through all the points of the meridian, commencing from the equator to which they are parallel, and terminating with the poles. They are called parallels of latitude, because all places lying under the same parallel, have the same latitude.

Parallels *of latitude*, in astronomy, are lesser circles of the sphere parallel to the ecliptic, imagined to pass through every degree and minute of the colures. They are represented on the globe by the divisions on the quadrant of altitude, in its motion round the globe, when screwed over the pole of the ecliptic. See Globe.

Parallels *of altitude*, or Almucantars, are circles parallel to the horizon, imagined to pass through every degree and minute of the meridian between the horizon and zenith, having their poles in the zenith. They are represented on the globe by the divisions on the quadrant of altitude, in its motion about the body of the globe, when screwed to the zenith.

Parallels *of declination*, in astronomy, are the same with parallels of latitude in geography.

Parallel *sphere*, that situation of the sphere, wherein the equator coincides with the horizon, and the poles with the zenith and nadir. In this sphere all the parallels of the equator become parallels of the horizon, consequently, no stars ever rise or set, but all turn round in circles parallel to the horizon; and the sun when in the equinoctial, wheels round the horizon the whole day. After his rising to the elevated pole, he never sets for six months; and after his entering again on the other side of the line, never rises for six months longer. This is the position of the sphere to such as live under the poles, and to whom the sun is never above 23° 30′ high.

Parallel *sailing*, in navigation, is the sailing under a parallel of latitude. See Navigation.

PARALLELEPIPED, or Parallelopiped, in geometry, a regular solid comprehended under six parallelograms, the opposite ones whereof are similar, parallel, and equal. All parallelepipeds, prisms, cylinders, &c. whose bases and heights are equal, are themselves equal. A diagonal plane divides a parallelepiped into two equal prisms; so that a triangular prism is half a parallelepiped, upon the same base, and of the same altitude.

All parallelepipeds, prisms, cylinders, &c. are in a ratio compounded of their bases and altitudes; wherefore, if their bases be equal, they are in proportion to their altitudes, and conversely. All parallelepipeds, cylinders, cones, &c. are in a triplicate ratio of their homologous sides, and also of their altitudes.

Equal parallelepipeds, prisms, cones, cylinders, &c. reciprocate their bases and altitudes.

PARALLELISM, the situation or quality whereby any thing is denominated parallel. See Parallel.

Parallelism *of the earth's axis*, in astronomy, that situation of the earth's

axis, in its progress through its orbit, whereby it is still directed towards the pole-star; so that if a line be drawn parallel to its axis, while in any one position, the axis, in all other positions, will be always parallel to the same line.

This parallelism is the result of the earth's double motion, *viz.* round the sun, and round its own axis; or its annual and diurnal motion; and to it we owe the vicissitudes of seasons, and the inequality of day and night.

Parallelism *of the rows of trees.* These are never seen parallel, but always inclining to each other towards the further extreme. Hence mathematicians have taken occasion to inquire in what lines the trees must be disposed to correct this effect of the perspective, and make the rows still appear parallel. The two rows must be such, as that the unequal intervals of any two opposite or correspondent trees may be seen under equal visual rays.

PARALLELOGRAM, in geometry, a quadrilateral right-lined figure, whose opposite sides are parallel and equal to each other. It is generated by the equable motion of a right line always parallel to itself. When it has all its four angles right, and only its opposite sides equal, it is called a rectangle or oblong. When the angles are all right, and the sides equal, it is called a square. If all the sides are equal, and the angles unequal, it is called a rhombus or lozenge; and if the sides and angles be unequal, it is called a rhomboides.

In every parallelogram, of what kind soever, a diagonal divides it into two equal parts; the angles diagonally opposite are equal; the opposite angles of the same side are together equal to two right angles; and each two sides, together, greater than the diagonal.

Two parallelograms on the same or equal base, and of the same height, or between the same parallels, are equal; and hence two triangles on the same base, and of the same height, are also equal. Hence, also, every triangle is half a parallelogram, upon the same or an equal base, and of the same altitude, or between the same parallels. Hence, also, a triangle is equal to a parallelogram, having the same base, and half the altitude, or half the base, and the same altitude.

Parallelograms, therefore, are in a given ratio, compounded of their bases and altitudes. If then the altitudes be equal, they are as the bases, and conversely.

In similar parallelograms and triangles, the altitudes are proportional to the homologous sides, and the bases are cut proportionably thereby. Hence similar parallelograms and triangles are in a duplicate ratio of their homologous sides; as also of their altitudes, and the segments of their bases; they are, therefore, as the squares of the sides, altitudes, and homologous segments of the bases.

In every parallelogram, the sum of the squares of the two diagonals is equal to the sum of the squares of the four sides. For if the parallelogram be rectangular, it follows that the two diagonals are equal; and, consequently, the square of a diagonal, or, which comes to the same thing, the square of the hypothenuse of a right angle, is equal to the squares of the sides. See Geometry.

Parallelogram, or Parallelism, a machine for the ready reduction of designs; it is the same with the Pentagraph, which see.

PARAMETER, in conic sections, a constant line, otherwise called *latus rectum.* The parameter is said to be constant, because, in the parabola, the rectangle under it and any absciss, is always equal to the square of the corresponding semi-ordinate; and in the ellipsis and hyperbola, it is a third proportional to the conjugate and transverse axis.

If t and c be the two axes in the ellipse and hyperbola, and x and y an absciss and its ordinate in the parabola: then

$t : c :: c : p = \frac{c^2}{t} =$ the parameter in the former;

$x : y :: y : p = \frac{y^2}{x} =$ the parameter in the last.

The parameter is equal to the double ordinate drawn through the focus of one of the three conic sections.

PARAMECIUM, in natural history, a genus of the Vermes Infusoria class and order. Worm invisible to the naked eye, simple, pellucid, flattened, oblong. There are seven species, of which P. aurelia is rather a large animalculum, membranaceous, pellucid, and about four times longer than it is broad; the fore-part obtuse, transparent, without intestines; the hind-part replete with molecules of various sizes; the fold which goes from the middle to the apex is a striking characteristic of the species, forming a kind of triangular aperture, and giving it somewhat the appearance of a gimblet. Its motion is rectilinear, reeling or staggering, and generally vehement. They are frequently found cohering lengthwise;

the lateral edges of both bodies appear bright. They may also be seen sometimes lying on one another alternately, at others adhering by the middle. They will live many months in the same water without its being renewed. They are found in the beginning of summer, in those ditches in which duck-weed abounds. P. chrysalis is found plentifully in salt water.

PARAPET, in fortification, an elevation of earth designed for covering the soldiers from the enemies' cannon or small shot. The thickness of the parapet is from eighteen to twenty feet; its height is six feet on the inside, and four or five on the outside. It is raised on the rampart, and has a slope above called the superior talus, and sometimes the glacis, of the parapet. The exterior talus of the parapet is the slope facing the country: there is a banquette or two for the soldiers who defend the parapet to mount upon, that they may the better discover the country, fosse, and counterscarpe, and fire as they find occasion. Parapet of the covert-way, or corridor, is what covers that way from the sight of the enemy, which renders it the most dangerous place for the besiegers, because of the neighbourhood of the faces, flanks, and curtins of the place.

PARAPET is also a little wall raised breast high, on the banks of bridges, keys, or high buildings, to serve as a stay, and prevent people's falling over.

PARAPHRASE, an explanation of some text, in clearer and more ample terms, whereby is supplied what the author might have said or thought on the subject; such are esteemed Erasmus's Paraphrase on the New Testament, the Chaldee Paraphrase on the Pentateuch, &c.

PARASANG, an ancient Persian measure, different at different times, and in different places; being sometimes thirty, sometimes forty, and sometimes fifty stadia, or furlongs.

PARASITES, or *Parasitical plants*, in botany, such plants as are supported by the trunk or branches of other plants, from whence they receive their nourishment, and will not grow upon the ground, as the misletoe, &c.

PARCENERS, in law, persons holding lands in copartnership, and who may be compelled to make division. It occurs where lands descend to the females, who all take equal shares of their deceased father's lands.

PARCHMENT, in commerce, the skins of sheep or goats, prepared after such a manner as to render it proper for writing upon, covering books, &c. The manufacture of parchment is begun by the skinner, and finished by the parchment-maker. The skin, having been stripped of its wool, and placed in the lime-pit, in the manner described under the article SHAMMY, the skinner stretches it on a kind of frame, and pares off the flesh with an iron instrument; this done it is moistened with a rag, and powdered chalk being spread over it, the skinner takes a large pumice-stone, flat at bottom, and rubs over the skin, and thus scowers off the flesh; he then goes over it again with the iron instrument, moistens it as before, and rubs it again with the pumice-stone without any chalk underneath: this smooths and softens the flesh-side very considerably. He then drains it again, by passing over it the iron instrument as before. The flesh-side being thus drained, by scraping off the moisture, he in the same manner passes the iron over the wool or hair side: then stretches it tight on a frame, and scrapes the flesh-side again: this finishes its draining: and the more it is drained, the whiter it becomes. The skinner now throws on more chalk, sweeping it over with a piece of lamb-skin that has the wool on, and this smooths it still further. It is now left to dry, and when dried, taken off the frame by cutting it all round. The skin, thus far prepared by the skinner, is taken out of his hands by the parchment-maker, who first, while it is dry, pares it on a summer, (which is a calf-skin stretched in a frame) with a sharper instrument than that used by the skinner, and working with the arm, from the top to the bottom of the skin, takes away about one half of its thickness. The skin, thus equally pared on the flesh side, is again rendered smooth, by being rubbed with the pumice-stone, on a bench covered with a sack stuffed with flocks, which leaves the parchment in a condition fit for writing upon. The parings thus taken off the leather, are used in making glue, size, &c. See GLUE, &c. What is called vellum, is only parchment made of the skins of abortives, or at least sucking calves. This has a much finer grain, and is whiter and smoother than parchment; but is prepared in the same manner, except its not being passed through the lime-pit.

PARDON, is the remitting or forgiving a felony or other offence committed against the King. Blackstone mentions

the power of pardoning offences to be one of the greatest advantages of monarchy, in general, above every other form of government, and which cannot subsist in democracies. Its utility and necessity are defended by him on all those principles which do honour to human nature.

Pardons are either general or special: general, as by act of Parliament, of which, if they are without exceptions, the court must take notice, *ex officio;* but if there are exceptions therein, the party must aver, that he is none of the persons excepted; special pardons, are either of course, as to persons convicted of manslaughter, or *se defendendo*, and by sevesal statutes, to those who shall discover their accomplices in several felonies; or of grace, which are by the king's charter, of which the court cannot take notice, *ex officio*, but they must be pleaded. A pardon may be conditional, that is, the King may extend his mercy upon what terms he pleases; and may annex to his bounty a condition, either precedent or subsequent, on the performance whereof the validity of the pardon will depend; and this by the common law.

All pardons must be under the great seal. The effect of a pardon is to make the offender a new man: to acquit him of all corporal penalties and forfeitures annexed to that offence, and to give him a new credit and capacity; but nothing but an act of Parliament can restore or purify the blood after an attainder.

PAREGORICS, medicines that assuage pain, otherwise called anodynes. See PHARMACY.

PARENCHYMA *of plants.* Grew applies the term parenchyma to the pith or pulp, or that inner part of a fruit or plant through which the juice is supposed to be distributed. This, when viewed with a microscope, appears to resemble marrow, or rather a sponge, being a porous, flexible, dilatable substance. Its pores are innumerable and exceeding small, receiving as much humour as is requisite to fill and extend them, which disposition of pores it is that is supposed to fit the plant for vegetation and growth.

PARENTS and CHILDREN, in law. If parents run away, and leave their children at the charge of the parish, the church-wardens and overseers, by order of the justices, may seize the rents, goods, and chattels of such persons, and dispose thereof towards their children's maintenance. A parent may lawfully correct his child, being under age, in a reasonable manner; but the legal power of the father over the persons of his children ceases at the age of twenty-one.

PARENTHESIS, in grammar, certain intercalary words, inserted in a discourse, which interrupt the sense, or thread, but seem necessary for the better understanding of the subject. The proper characteristic of a parenthesis is, that it may be either taken in or left out, the sense and the grammar remaining entire. In speaking, the parenthesis is to be pronounced in a different tone,; and in writing, it is enclosed between ( ), called also a parenthesis, but commonly a bracket, or crotchet, to distinguish it from the rest of the discourse. The politest of our modern writers avoid all parenthesis, as keeping the mind in suspense, embarrassing it, and rendering the discourse less clear, uniform, and agreeable.

PARHELIUM, of PARHELION, in physiology, a mock sun, or meteor, in form of a very bright light, appearing on one side of the sun. The parhelia are formed by the reflection of the sun's beams on a cloud properly posited. They usually accompany the coronæ, or luminous circles, and are placed in the same circumference, and at the same height. Their colours resemble that of the rainbow; the red and yellow are on the side towards the sun, and the blue and violet on the other. There are coronæ sometimes seen without parhelia, and *vice versa.* Parhelia are double, triple, &c. and in 1629, a parhelion of five suns was seen at Rome; and in 1666, another at Arles, of six. M. Mariotte accounts for parhelia from an infinity of little particles of ice floating in the air, that multiply the image of the sun by refraction or reflection; and by a geometrical calculus, he has determined the precise figure of these little icicles, their situation in the air, and the size of the coronæ of circles which accompany the parhelia, and the colours wherewith they are painted. M. Huygens accounts for the formation of a parhelion in the same manner as for that of the halo.

PARIAN *chronicle.* See ARUNDELIAN *marbles.*

PARIANA, in botany, a genus of the Monoecia Polyandria class and order. Essential character: male, flowers in whorls, forming spikes; calyx two-valved; corolla two-valved, larger than the calyx; filaments forty: female, flowers solitary in each whorl; calyx two-valved; corolla two-valved, less than the calyx; stigmas two; seed three-cornered, in-

closed. There is but one species, *viz.* P. campestris, a native of the woods in the island of Cayenne.

PARIETARIA, in botany, *pellitory*, a genus of the Polygamia Monoecia class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: two hermaphrodite flowers, and one female flower in a flat six-leaved involucre: calyx four-cleft; corolla none; style one; seed one, superior, elongated: hermaphrodite, stamina four: female, stamina none. There are ten species.

PARIS, in botany, a genus of the Octandria Tetragynia class and order. Natural order of Sarmentaceæ. Asparagi, Jussieu. Essential character: calyx four-leaved; petals four, narrower; berry four-celled. There is but one species, *viz.* P. quadrifolia, herb Paris, true-love, or one-berry.

PARISH, signifies the precinct of a parish church, and the particular charge of a secular priest. Formerly a parish was sononymous with diocese, and the tythes were paid to any priest whom the party chose, but it was found convenient to allot a certain district for each priest, that he alone might receive the tythe. It is very doubtful when they originated. Some place the division of parishes in A. D. 630, others in 1179. A parish may contain one or more vills, but it is presumed to contain only one, and anciently was co-extenive with the manor. Money given by will to a parish is given to the poor. These districts are computed to be nearly ten thousand in number.

PARISH *clerk*. In every parish the parson, vicar, &c. hath a parish clerk under him, who is the lowest officer of the church. These were formerly clerks in orders, and their business at first was to officiate at the altar, for which they had a competent maintenance by offerings; but now they are laymen, and have certain fees with the parson, on christenings, marriages, burials, &c. besides wages for their maintenance. He must be twenty years of age, and of honest conversation, and is generally appointed by the minister, unless there is a custom for the churchwardens and parishoners to elect. It is an office for life, and a freehold. He may make a deputy without licence from the bishop.

PARISHIONER, an inhabitant of, or belonging to, any parish, lawfully settled there. Parishioners are a body politic to many purposes; as to vote at a vestry if they pay scot and lot; and they have a sole right to raise taxes for their own relief, without the interposition of any superior court; may make by-laws to mend the highways, and to make banks to keep out the sea, and for repairing the church, and making a bridge; and for making and maintaining fire engines. They may also purchase workhouses for the poor, or any such thing for the public good.

PARKINSONIA, in botany, so named in memory of John Parkinson, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx five-cleft; petals five, ovate, the lowest kidney-form; style none; legume necklace form. There is but one species, *viz.* P. aculeata, prickly Parkinsonia. It is a native of Jamaica, where it is called Jerusalem thorn.

PARLIAMENT. The parliament is the legislative branch of the supreme power of Great Britain, consisting of the King, the Lords spiritual and temporal, and the Knights, citizens, and Burgesses, representatives of the Commons of the Realm, in Parliament assembled.

The power and jurisdiction of Parliament is so transcendent and absolute, that it cannot be confined, either for causes or persons, within any bounds.

The Parliament must be summoned by the King, and not by authority of either house, at least forty days before it sits, although the Convention Parliament (the House of Commons), from necessity, was summoned by the Keepers of the Liberty of England, by authority of Parliament. It cannot begin without the King in person, or by representation. The principal privileges of Parliament are the privilege of speech, which is essential to its existence, and to which there are no exceptions, except in some precedents of information filed for using free language during the reign of the second Charles, which it is to be hoped will never be drawn into authority, and the privilege of person from arrest and imprisonment for debt. This privilege lasts for forty days after the prorogation of the Parliament, and forty days previous to its meeting. But all other privileges, derogating from the common laws and matters of civil right, are abolished by several statutes; and by 4 George III. c. 33, a trader, being a Member of Parliament, may be served with legal process for any just debt to the amount of one hundred pounds, and unless he makes satisfaction within two months, it shall be an act of bankruptcy. Vide statutes 12 William III. c. 3; 2 and 3 Ann, c. 18; 11 George II. c.

24. Statute 10 George III. c. 50; 4 George III. c. 33.

It is one of the privileges of the Peers to be entitled to vote by proxy, and also to enter a protest against any bill to which they may dissent. But all money bills must commence with the Commons; and it is now the custom, if any alteration is made by the Lords in a money bill, for the commons to reject it and bring in another, even though the new bill should contain the regulation proposed by the Lords.

The House of Commons is a denomination given to the lower house of Parliament. In a free state, every man who is supposed a free agent, ought to be in some measure his own governor, and therefore a branch at least of the legislative power should reside in the whole body of the people. In elections for representatives for Great Britain, anciently, all the people had votes; but King Henry VI. to avoid tumults, first appointed that none should vote for knights but such as were freeholders, did reside in the county, and had forty shillings yearly revenue. In so large a state as ours, therefore, it is very wisely contrived that the people should do that by their representatives, which it is impracticable to perform in person; representatives chosen by a number of minute and separate districts, wherein all the voters are, or may be, easily distinguished. The counties are therefore represented by knights, elected by the proprietors of lands; the cities and boroughs are represented by citizens and burgesses, chosen by the mercantile, or supposed trading interest of the nation.

The peculiar laws and customs of the House of Commons, relate principally to the raising of taxes, and the elections of members to serve in Parliament.

The method of making laws is nearly the same in both houses. In the House of Commons, in order to bring in the bill, if the relief sought be of a private nature, it is first necessary to prefer a petition, which must be presented by a member, and usually sets forth a grievance required to be remedied. This petition, when founded on facts of a disputable nature, is referred to a committee of members, who examine the matter alleged, and accordingly report it to the house; and then (or otherwise upon the mere petition), leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the house, without any petition. If the bill begin in the House of Lords, if of a private nature, it is referred to two judges, to make report. After the second reading, the bill is said to be committed, that is, referred to a committee, which is selected by the house, in matters of small importance; or, upon a bill of consequence, the house resolves itself into a committee of the whole house; a committee of the whole house is composed of every member, and to form it the Speaker quits the chair, and may consequently sit and debate upon the merits of it as a private member, another member being appointed chairman for the time. In these committees the bill is usually debated clause by clause, amendments made, and sometimes it is entirely new modelled. Upon the third reading, further amendments are sometimes made, and if a new clause be added, it is done by tacking a separate piece of parchment on the bill, which is called a rider. The royal assent may be given two ways. 1. In person, when the King comes to the House of Peers, in his crown and royal robes, and sending for the Commons to the bar, the titles of all the bills that have passed both houses are read, and the King's answer is declared by the clerk of the Parliament. If the King consent to a public bill, the clerk usually declares, *le Roy le veut*, the King wills it so to be; if to a private bill, *soit fait comme il est desire*, be it as it is desired. If the King refuse his assent, it is in the gentle language of *le Roy s'avisera*, the King will advise upon it. When a bill of supply is passed, it is carried up and presented to the King by the Speaker of the House of Commons, and the royal assent is thus expressed, *le Roy remercie ses loyal sujets, accepte leur benevolence, et aussi le veut*, the King thanks his loyal subjects, accepts their benevolence, and also wills it so to be. By the statute 33 Henry VIII. c. 21, the King may give his assent by letters patent under his great seal, signed with his hand, and notified in his absence to both houses assembled together in the upper house. And when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament.

An act of parliament thus made, is the exercise of the highest authority that this kingdom acknowledges upon the earth. It has power to bind every subject in the land, and the dominions thereunto belonging; nay even the King himself if particularly named therein. And it can-

not be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority of Parliament.

Adjournment is no more than a continuance of the session from one day to another, as the word itself signifies; and this is done by the authority of each house separately every day, or for a longer period; but the adjournment of one house, is no adjournment of the other.

Prorogation is the continuance of the Parliament from one session to another, as an adjournment is a continuation of the session from day to day. And this is done by the royal authority, expressed either by the Lord Chancellor, in his Majesty's presence, or by commission from the crown, or frequently by proclamation; and by this, both houses are prorogued at the same time; it not being a prorogation of the House of Lords or Commons, but of the Parliament. The session is never understood to be at an end, until a prorogation; though, unless some act be passed, or some judgment given in Parliament, it is, in truth, no session at all.

A dissolution is the civil death of the Parliament; and this may be effected three ways; 1. by the King's will, expressed either in person or representation; 2. by the demise of the crown; 3. by length of time. By the King's will; for as the King hath the sole right of convening the Parliament, so also it is a branch of the royal prerogative, that he may, whenever he pleases, prorogue the Parliament for a time, or put a final period to its existence.

By the demise of the crown; a dissolution formerly happened immediately upon the death of the reigning sovereign; but the calling a new Parliament immediately on the inauguration of the successor being found inconvenient, and dangers being apprehended from having no Parliament in being, in case of a disputed succession, it was enacted, by statutes 7 and 8 Will. III. c. 15, and 6 Anne, c. 7, that the Parliament in being shall continue for six months after the death of any King or Queen, unless sooner prorogued or dissolved by the successor. That if the Parliament be, at the time of the King's death, separated by adjournment or prorogation, it shall notwithstanding assemble immediately; and that if no Parliament is then in being, the members of the last Parliament shall assemble and be again in Parliament. Lastly, a Parliament may be dissolved or expire by length of time.

The utmost extent of time that the same Parliament was allowed to sit by the statute of 6 William, c. 3, was three years; after the expiration of which, reckoning from the return of the first summons, the Parliament was to have no longer continuance. But by statute 1 George I. c. 38, in order, as it was alleged, to prevent the great and continued expences of frequent elections, and the violent heats and animosities consequent thereupon, and for the peace and security of the government just then recovering from the last rebellion, this term was prolonged to seven years. So that as our constitution now stands, the Parliament must expire, or die a natural death, at the end of every seventh year, if not sooner dissolved by the royal prerogative. In favour of liberty, however, it were much to be wished that this statute had never been passed. The pretexts which it assigns, as the grounds upon which it was passed, are all fallacious.

Parliament, *the High Court of*, is the supreme court of the kingdom, not only for the making, but also for the execution of laws, by the trial of great and enormous offenders, whether lords or commoners, in the method of parliamentary impeachment. An impeachment before the Lords, by the Commons of Great Britain in Parliament, is a prosecution of the already known and established law, and has been frequently put in practice; being a presentment to the most high and supreme court of criminal jurisdiction, by the most solemn grand inquest of the whole kingdom. A commoner cannot, however, be impeached before the Lords for any capital offence, but only for high misdemeanors; a peer may be impeached for any crime. And they usually, in case of an impeachment of a peer for treason, address the crown to appoint a lord high steward, for the greater dignity and regularity of their proceedings; which high steward was formerly elected by the peers themselves, though he was generally commissioned by the king; but it has of late years been strenuously maintained, that the appointment of a high steward in such cases is not indispensably necessary; but the house may proceed without one. The articles of impeachment are a kind of bills of indictment, found by the House of Commons, and afterwards tried by the Lords; who are in cases of misdemeanors

considered not only as their own peers, but as the peers of the whole nation.

Much has been said and written upon the question of parliamentary reform, and the actual state of the Parliament. The result of a candid inquiry will be this; namely, that the Parliament, which has been, and now is the guardian of the liberties of the people, may hereafter by corruption become the means of their destruction, or the cause of their being surrendered, and the Parliament itself have only a nominal existence. To prevent this, the people can only depend upon the frequent necessity of their representatives appealing to them for a renewal of their powers; that is, upon the frequency of elections, which, in order also to be free, should be made by as large a body of voters as possible, and that what are called rotten boroughs should at once be abolished. To object to this, that it is an infringement of chartered rights, is an insult to common sense; for all charters are void that are against common right, and the only object of elections is for the benefit of the many, not for the private advantage of the few. That the present state of the representation of the people is not such as it ought to be has been too generally admitted to be insisted upon here; but let it never be forgotten, that amongst those who have considered it as defective we must number Mr. Pitt, Mr. Fox, and the commentator Blackstone. In any future revision of the laws against bribery and corruption, it would be well to make the elected as well as the electors take the oath against bribery; and still further to narrow, though not wholly to exclude, the admission of placemen and contractors to seats in the House of Commons. If the freedom of the press can be fully preserved, or obtained, we may venture to hope that every thing will ultimately be effected which the rational friends of freedom can desire; but a knowledge of our history will teach us, that little is to be gained for liberty by adherence to any precedents drawn from proceedings before the Revolution, the true principles of which are the only genuine grounds on which to rest the foundation of British liberty.

PARNASSIA, in botany, a genus of the Pentandria Tetragynia class and order. Natural order of Capparides, Jussieu. Essential character: calyx five-parted; petals five; nectaries five, cordate, ciliate, with globular apexes; capsule four-valved. There is but one species, *viz*. P. palustris, common marsh parnassia, or grass of Parnassus.

PARODICAL, *degrees of an equation*, in algebra, are the several regular terms in quadratic, cubic, biquadratic equations, &c. the indexes of whose powers ascend or descend orderly in an arithmetical progress, as $z^3+z^2\,m+z\,r=s$, is a cubical equation, where no term is wanting, but having all its parodic degrees, the indexes of the terms regularly descending.

PARODY, a popular maxim, adage, or proverb. Parody is also a poetical pleasantry, consisting in applying the verses written on one subject, by way of ridicule, to another; or in turning a serious work into a burlesque, by affecting to observe, as nearly as possible, the same rhymes, words, and cadences. It comes nearly to what some of our late writers call travesty; and was first set on foot by the Greeks, from whom we borrow the name.

PAROLE, a term signifying any thing done verbally or by word of mouth, in contradistinction to what is written: thus, an agreement may be by parole. Evidence also may be divided into parole evidence and written evidence. A parole-release is good to discharge a debt by simple contract. The holder of a bill of exchange may authorize another to indorse his name upon it by parole; and generally all agreements by parole are good, except such as are within the statute of frauds, and particularly such as relate to lands, and agreements for any term beyond three years in lands or houses, and also all executory agreements for the sale of goods above 10*l*. not forfeited by delivery. See AGREEMENT and LEASE.

PARRA, the *jacana*, in natural history, a genus of birds of the order Grallæ. Generic character: bill slender and sharply pointed, the base carunculated; nostrils in the middle, and somewhat oval; wings spinous; toes four, very long, and claws sharply pointed and long. There are sixteen species mentioned by Gmelin. Latham notices nine.

P. jacana, or the chesnut jacana, is the size of the water rail, frequents the watery places of South America, and is extremely clamorous. These birds often wade up to the thighs in water, are particularly shy, scarcely ever seen but in pairs, and when separated, incessantly calling for each other till a reunion is accomplished. They are called by the

French chirurgieus. Their flesh is valued.

P. chavaria is as large as a dunghill cock, with legs extremely long and strong, and toes so lengthened as to entangle in each other in its walking, on which account its usual movement on the ground is slow, and without the assistance of its wings it is incapable of running. Its flight, however, is rapid, and it is able to swim with ease. Its principal residence is about Carthagena in South America, where it is usual for the breeders of poultry to keep one of these birds tame, which attend their flocks as centinel, and effectually secures them from birds of prey. Its immense spurs are dreaded and avoided, even by the vulture. It is said to feed on vegetables.

PARROT. See PSITTACUS.

PARSON, signifies the rector of a church. He is in himself a body corporate, in order to protect and defend the rights of the church by a perpetual succession. When a parson is instituted and inducted into a rectory, he is then, and not before, in full and complete possession. A parson has regularly during life the freehold in himself of the parsonage-house, the glebe, or land annexed to the parsonage, and the tythes and other dues; but these are sometimes in the hands of an appropriator, and then there is a vicar, who is endowed with a portion of the glebe and of the tythes.

PARTS *of speech*, in grammar, are all the sorts of words which enter the composition of discourse.

The grammarians generally admit of eight parts of speech, *viz.* noun, pronoun, verb, participle, adverb, preposition, interjection, and conjunction. See GRAMMAR.

PARTHENIUM, in botany, a genus of the Monoecia Pentandria class and order. Natural order of Nucamentaceæ. Corymbiferæ, Jussieu. Essential character: male, calyx common five-leaved; corolla of the disk one-petalled: female, corolla of the ray five; on each side two males, with one female between superior. There are two species, *viz.* P. hysterophorus, cut-leaved parthenium, or bastard feverfew, and P. integrifolium, entire-leaved parthenium; the former is an annual plant, growing naturally in Jamaica, where it is called wild wormwood; it thrives very luxuriantly in the low lands; it is observed to possess similar qualities with feverfew; it flowers here in July and August.

PARTI, PARTIE, PARTY, or PARTED, in heraldry, is applied to a shield or escutcheon, denoting it divided or marked out into partitions.

The French heralds, from whom we borrow the word, have but one kind of parti, the same with our parti per pale, which they simply call parti; but with us the word is applied to all sorts of partitioning, and is never used without some addition, to specify the particular kind intended: thus we have parti, or parted, per cross, per chief, per pale, per fess, per bend dexter, per bend sinister, per chevron, &c.

PARTICIPLE. See GRAMMAR.

PARTICLE, in physiology, the minute part of a body, an assemblage of which constitute all natural bodies. See ATOMICAL *philosophy.*

It is the various arrangement and texture of these particles, with the difference of cohesion, &c. that constitute the various kinds of bodies. The smallest particles cohere with the strongest attraction, and compose bigger particles of weaker cohesion, and many of these cohering compose bigger particles, whose vigour is still weaker; and hereupon the operations in chemistry, and the colours of natural bodies depend, and which, by cohering, compose bodies of sensible bulk. The cohesion of the particles of matter, the Epicureans imagined, was effected by the means of hooked atoms; the Aristotelians, by rest; but Sir Isaac Newton shews, that it is done by means of a certain power, whereby the particles mutually attract and tend towards each other. By this attraction of the particles, he shews that most of the phenomena of the lesser bodies are affected, as those of the heavenly bodies are, by the attraction of gravity.

In investigating the actions exerted between minute particles of matter, we must distinguish them as acted upon by the force of aggregation, or the force of chemical affinity: hence the distinction between the integrant and constituent particles of bodies. The constituent parts are substances differing in their nature from each other, and from the substance which they form. The integrant parts are precisely similar to each other, and to the general mass which is composed by their union, or, in other words, they are the smallest particles into which a substance can be resolved without decomposition; while decomposition is always implied in the division of a body into its constituent particles. The integrant

parts are united by the force of aggregation, the constituent parts by chemical affinity. Hence chemists say that simple bodies consist entirely of integrant parts, all their particles being alike in their properties. But compounds may be considered as consisting both of integrant and constituent parts; and it has been supposed, that when an attraction is exerted between two compound substances, it is between their integrant parts, not their constituent principles, and that it is the combination of the former which constitutes the substance formed by their union.

Particle, in grammar, a denomination for all those small words that tie or unite others together, or that express the modes or manners of words, usually included by grammarians under these four parts of speech, *viz.* adverbs, prepositions, interjections, and conjunctions.

PARTIES, are those which are named in a deed or fine, as parties to it. See Fine.

PARTITION, is a dividing of lands descended by the common law or custom, among coheirs or parceners, where there are two at the least.

PARTITION, in music, the disposition of the several parts of a song set on the same leaf, so as upon the uppermost ranges of lines are found the treble; in another, the bass; in another, the tenor, &c. that they may be all sung or played, either jointly or separately.

PARTNERSHIP, in arithmetic. See Fellowship.

PART-OWNERS, are partners interested and possessed of certain shares in a ship. Owners are tenants in common with each other; but one or more joint-owners refusing to contribute their quota to the outfit of the vessel, cannot prevent her from going to sea against the consent of the majority of the owners, who, giving security in the Admiralty, may freight the ship at their own exclusive risk, by which the smaller dissentient number of owners will be excluded at once from any share, either in the risk or in the profits. See Shipping.

PARTRIDGE. See Tetrao.

PARUS, the *titmouse,* in natural history, a genus of birds of the order Passeres. Generic character: bill strait, somewhat compressed, strong, hard, and pointed; nostrils round, and covered with bristles turned back over them from the base of the bill; tongue truncated, and bristly at the end; toes divided to their origin, the back one very large and strong. These birds are found in almost every part of the old Continent, from the north of Europe to the south of India, and are highly prolific, laying eighteen or twenty eggs, which they hatch with unwearied patience. They build their nest with particular neatness and skill, and frequently on the extremity of some branch suspended over water, by which they secure it from the attack of various animals to which it might otherwise fall a prey. They are wonderfully active and alert, rapid and assiduous in their search for insects, on which they principally subsist, under the bark and in the crevices of trees, which they clear of the immense multitudes of caterpillars covering them in spring, and which would totally blast their vegetation. They are in no country migratory, though they occasionally change their residence for short distances. They are impassioned and irascible to a great degree, and when irritated will display that ardent eye and muffled plumage which indicate the paroxysm of agitation. Their courage is of the first order, as they are known sometimes to attack birds three times their size. Even the owl is by no means secure from their rage, and whatever bird they pursue, their first attempts are levelled at the head, and particularly at the eyes and brains, the latter of which they eat with particular avidity and relish. Gmelin enumerates thirty-one species, and Latham twenty-seven.

P. major, or the greater titmouse of Europe, weighs about an ounce. The male and female associate for some time before they begin to build, which they do with the most downy materials, and generally in the hole of some tree. The young continue blind for several days, and after they have left the nest never return to it, but continue, however, in the same neighbourhood, with the appearance of great family attachment, till the ensuing spring. See Aves, Plate X. fig. 7.

P. cæruleus, or the blue titmouse of Europe, is eminently beautiful, and highly serviceable in destroying caterpillars in orchards and gardens. It picks the bones of small birds to the most complete cleanness, and is distinguished by the bitterness of its aversion to the owl. See Aves, Plate X. fig. 8.

P. caudatus, or the long-tailed titmouse of Europe, lives in the same manner as the former, and has the same general ha-

bits with the rest of the genus, but builds its nest with peculiar care and elegance, securing, in the completest manner, the two important circumstances of dryness and warmth; the silken threads of aurelias constitute a principal article for those purposes. It is active even to restlessness, perpetually flying backwards and forwards, and running up and down the branches of trees in every possible direction. It possesses all the fullness of plumage of the owl.

PASCAL (Blaise), a respectable French mathematician and philosopher, and one of the greatest geniuses and best writers that country has produced. He was born at Clermont in Auvergne, in the year 1623. His father, Stephen Pascal, was president of the Court of Aids in his province: he was also a very learned man, an able mathematician, and a friend of Des Cartes. Having an extraordinary tenderness for this child, his only son, he quitted his province, and settled at Paris in 1631, that he might be quite at leisure to attend to his son's education, which he conducted himself, and young Pascal never had any other master. From his infancy Blaise gave proofs of a very extraordinary capacity. He was extremely inquisitive; desiring to know the reason of every thing; and when good reasons were not given him, he would seek for better; nor would he ever yield his assent but upon such as appeared to him well grounded. What is told of his manner of learning the mathematics, as well as the progress he quickly made in that science, seems almost miraculous. His father, perceiving in him an extraordinary inclination to reasoning, was afraid lest the knowledge of the mathematics might hinder his learning the languages, so necessary as a foundation to all sound learning. He therefore kept him as much as he could from all notions of geometry, locked up all his books of that kind, and refrained even from speaking of it in his presence. He could not however prevent his son from musing on that science: and one day in particular he surprised him at work with charcoal upon his chamber floor, and in the midst of figures. The father asked him what he was doing: I am searching, says Pascal, for such a thing; which was just the same as the 32d proposition of the 1st book of Euclid. He asked him then how he came to think of this: it was, said Blaise, because I found out such another thing; and so, going backward, and using the names of *bar* and *round*, he came at length to the definitions and axioms he had formed to himself. From this time he had full liberty to indulge his genius in mathematical pursuits. He understood Euclid's Elements as soon as he cast his eyes upon them. At sixteen years of age he wrote a treatise on Conic Sections, which was accounted a a great effort of genius; and therefore it is no wonder that Des Cartes, who had been in Holland a long time, upon reading it, should choose to believe that M. Pascal the father was the real author of it. At nineteen he contrived an admirable arithmetical machine, which would have done credit as an invention to any man versed in science. About this time his health became impaired, so that he was obliged to suspend his labours for the space of four years. After this, having seen Torricelli's experiment respecting a vacuum and the weight of the air, he turned his thoughts towards these objects, and undertook several new experiments, by which he was fully convinced of the general pressure of the atmosphere; and from this discovery he drew many useful and important inferences. He composed also a large treatise, in which he fully explained this subject, and replied to all the objections that had been started against it. As he afterwards thought this work rather too prolix, and being fond of brevity and precision, he divided it into two small treatises, one of which he entitled, "A Dissertation on the Equilibrium of Fluids;" and the other, "An Essay on the Weight of the Atmosphere." These labours procured Pascal so much reputation, that the greatest mathematicians and philosophers of the age proposed various questions to him, and consulted him respecting such difficulties as they could not resolve. Upon one of these occasions he discovered the solution of a problem proposed by Mersenne, which had baffled the penetration of all that had attempted it. This problem was to determine the curve described in the air by the nail of a coach-wheel, while the machine is in motion; which curve was thence called a roullette, but now commonly known by the name of cycloid. Pascal offered a reward of forty pistoles to any one who should give a satisfactory answer to it. No person having succeeded, he published his own at Paris; but under the name of A. d'Ettonville. This was the last work which he published in the mathematics; his infirmities, from a delicate constitution, though still young, now increasing so much, that he was under the necessity of

renouncing severe study, and of living so recluse, that he scarcely admitted any person to see him.

After having thus laboured abundantly in mathematical and philosophical disquisitions, he forsook those studies and all human learning at once, to devote himself to acts of devotion and penance. He was not twenty-four years of age, when the reading some pious books had put him upon taking this resolution; and he became as great a devotee as any age has produced. He now gave himself up entirely to a state of prayer and mortification; and he had always in his thoughts these great maxims of renouncing all pleasure and all superfluity; and this he practised with rigour even in his illnesses, to which he was frequently subject, being of a very invalid habit of body. He died at the age of thirty-nine. His works were collated and published at the Hague in five volumes 8vo. by the Abbé Bossu, 1779.

Pascal *rents*, rents or annual duties paid by the inferior clergy to the bishop or archdeacon, at their Easter visitation.

PASPALUM, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, orbicular; corolla of the same size; stigmas pencilled. There are fifteen species. All these grasses are of foreign growth, none of them natives of Europe.

PASSAGE. In stat. 4 Edward III. c. 7, this term is used for the hire a man pays for being transported over any sea or river. Various statutes of a local nature have been passed for regulating the passage of particular rivers. By a statute of Edward IV. the passage from Kent to Calais is restrained to Dover.

Passage, *birds of*, a name given to those birds which at certain stated seasons of the year remove from certain countries, and at other stated times return to them again, as our quails, woodcocks, storks, nightingales, swallows, and many other species. The generality of birds that remain with us all the winter have strong bills, and are enabled to feed on what they can find at that season; those which leave us, have usually very slender bills, and their food is the insects of the fly kind, which disappearing towards the approach of winter, compel them to seek them in the warmer regions where they are to be found. Among the birds of passage, the fieldfare, the redwing, the woodcock, and the snipe, come to us in the autumn, at the time when the summer birds are leaving us, and go from us again in spring, at the time when these return; and of these the two last often continue with us through the summer, and breed; so that the two first seem the only kinds that certainly leave us at the approach of spring, retiring to the northern parts of the continent, where they live during the summer, and breed; and, at the return of winter, are driven southerly from those frigid climes, in search of food, which there the ice and snow must deprive them of.

Passage, *right of*, in commerce, is an imposition or duty exacted by some princes, either by land or sea, in certain close and narrow places in their territories, on all vessels and carriages, and even sometimes on persons or passengers coming in or going out of ports, &c. The most celebrated passage of this kind in Europe is the Sound, the dues for passing which straight belong to the King of Denmark, and are paid at Elsenore or Cronenburg.

PASSANT, in heraldry, a term applied to a lion, or other animal, in a shield, appearing to walk leisurely: for most beasts, except lions, the term trippant is frequently used instead of passant.

PASSERES, in natural history, the sixth order of birds, according to the Linnæan system; they are distinguished by a conical and pointed bill; nostrils oval, pervious, naked; legs formed for hopping; toes slender, divided; body slender, flesh of such as feed on grain pure; of those which feed on insects impure; nest formed with much art. They live chiefly in trees and hedges, are monogamous, vocal, and feed the young by thrusting the food down their throats. They are thus divided: the genera in A have thick bills, as the

Colius	Loxia
Emberiza	Phitoloma.
Fringilla	

Those in B have the upper mandible somewhat hooked at the point: as the

Caprimulgus	Hirundo.
Pipra	

Those in C have the upper mandible notched near the end; as the

Ampelis	Tanagra
Muscicapa	Turdus.

Those in D have the bill straight, simple, tapering: as the

Alauda	Parus
Columba	Sturnus.
Motacilla	

PASSERINA, in botany, *sparrow-wort*, a genus of the Octandria Monogynia class and order. Natural order of Vepreculæ. Thymeleæ, Jussieu. Essential character; calyx none; corolla four-cleft: stamina placed on the tube; seed one, corticate. There are nineteen species, chiefly natives of the Cape of Good Hope and New Zealand.

PASSIFLORA, in botany, *passion-flower*, a genus of the Gynandria Pentandria class and order. Natural order of Cucurbitaceæ. Essential character: styles three; calyx five-leaved; petals five; nectary a crown; berry pedicelled. There are thirty-seven species, of which we shall notice the P. cærulea, common or blue passion flower. This tree rises in a few years to a great height, with proper support, the shoots often growing to the length of ten or twelve feet in one summer: at each joint is one leaf, composed of five smooth entire lobes; their footstalks are nearly two inches long, having two embracing stipules at their base; from the same point issues a long clasper, or tendril, the flowers come out at the same joint with the leaves, on peduncles three inches long; they have a faint scent, lasting only one day; fruit egg-shaped, the size and shape of the Mogul plum, when ripe of the same yellow colour, inclosing a sweetish disagreeable pulp, in which are lodged oblong seeds. The blue passion flower grows naturally in Brazil. It is now become the most common species in England, being sufficiently hardy to thrive in the open air.

These beautiful plants were unknown till the discovery of America; they are found in various parts, both of the continent, chiefly of South America, and the islands.

PASSION, *or the Passions*. The latter term serves to express those sensations of the soul excited by pleasure and pain; which two principal feelings are divided into a variety of branches, and those we shall endeavour, in the succeeding pages, to explain, as far as our limited powers will permit.

The passions are, in a great degree, selfish; and yet, fortunately for the general benefit of the human race, they are far from being entirely so.

Fear may be said to be entirely confined to self-love in many instances, but this passion is frequently extended in a secondary state to an apprehension for the well-being of others, in whose happiness we feel deeply interested; and yet it may admit of doubt whether the idea of being deprived of some previously experienced pleasure may not influence and promote our apparently disinterested affection. Indeed there are philosophers who attribute all our passions and actions to the sole motive of self-love, though we hope and trust erroneously.

Various theories have been published, by which their authors have endeavoured to elucidate the manner in which the passions are excited in and act upon the soul, the agitation of which is expressed in many different modes by the features and muscles. Indeed, the language of this ethereal and inexplicable spirit speaks through every fibre, and each passion is known to an indifferent spectator, without the intervention of an explanatory sound. It would seem, from the sudden and involuntary experience of agitation, that the passions were implanted in the soul as centinels watchful for its safety, and that of the person it inhabits. Were this the truth, some have observed, it might be supposed, that every impulse would be found correct and proper: sad conviction, however, proves, it is added, that nothing can be more ill-founded than such a supposition, as not an individual exists at this moment who has not discovered, that he has feared where he ought to have esteemed, hated when he ought to have admired, loved when he ought to have detested, and in numerous instances been blinded either by misconceived partiality, or equally unjust prejudice. Such, at least, is the decision of unthinking persons; those, on the contrary, who do justice to the Creator, feel and acknowledge, that the passions are the most correct of centinels, particularly when guided and governed by the superior gift of reason.

Accident may have distorted the features, and deranged the graceful turn of the limbs of an unfortunate individual; by this means he becomes an object of disgust, and he probably resembles the wretch who commits midnight assassination, or secretly stabs reputation by malicious inferences: let this unhappy person meet unexpectedly with two others, who have never seen him before, one un-

der the influence of uncontrolled passions, and the other completely master of them; the former exclaims with terror, and shuns the presence of the ill-favoured mortal; the latter receives the same alarm from the soul, but giving the reins to reason, a cool examination takes place, and by reading the mind of the terrific object, he finds nothing to fear, but probably much to admire and esteem, and perhaps secures a friend, which the other loses by absurd precipitation.

The passion of fear has evidently been implanted in us, in order to preserve the extremely frail and delicate organs which compose our bodies; but such is the perverseness of our education, that this very passion is frequently the immediate cause of our destruction. This certainly never could have been the case, had we been taught from our infancy to govern it by reason: the prescience of the soul shows instantaneously the extent of the danger to be apprehended; were the impulse less arbitrary, it would be disregarded; the alarm given, reason is always at hand to suggest the means of preservation; nor can her dictates frequently fail, though it must be admitted circumstances do sometimes exist which preclude a possibility of extrication.

In reasoning upon this subject, facts ought to supersede theory, and it should be our endeavour, at least, to be of service to the community, by showing the public their errors from their own conduct. In this particular it is, unhappily, in our power to cite a recent instance of the fatal effects of uncontrolled fear. We allude to the loss of eighteen lives, in October, 1807, at Sadler's Wells, where the brutal conduct of two persons in a state of intoxication, insulting every person near them, excited alarm in some weak females, seated above them in the boxes; which natural and necessary emotion was suffered, by indulgence, to confound their senses of seeing, hearing, and smelling, to such a degree as to derange their ideas even to madness. In this state of fear they exhibited the most frantic gestures, exclaimed fire in their delirium, and soon lost the power of delivering themselves from the supposed danger. The horror of being burned to death immediately spread; all ranks of persons, from the pit to the gallery, obeyed the dictates of fear, and each endeavouring to escape, pressure, and suffocation, and death followed. The performers, in full possession of their faculties, terrified at the scene before them, joined with the managers, by signs and intreaties, to obtain quiet and silence, in vain. In vain did they urge that the stage could not be on fire and they not be sensible of it; in vain did they exclaim, even with speaking trumpets, that the audience themselves might perceive that smoke or flame appeared in no part of the theatre. Still they fled to certain suffocation, still they precipitated themselves from the gallery to the pit, till the place was nearly emptied.

Such is the simple narrative of this dreadful scene; but how is it to be accounted for?

Were we to argue from the precise occurrences of the scene just described, we must suppose that the perceptions of the soul are greatly confined or limited; that confused or imperfect sounds, striking upon the drum of the ear, convey ideas to the former which it is incapable of separating and appropriating; but that, being rouzed to a sense of some sort of danger, resemblances are taken for originals. Thus, perhaps, some of the execrations uttered by the rioters may have sounded like the word fire, to the female or females who repeated it, whose weakness and want of resolution deprived them of the power of ascertaining, from every surrounding object, that the conceptions of their fears were utterly unsupported by facts. Nor was their faculty of recollection sufficiently strenuous to remind them, that the passages from the boxes of the theatre they were in were so capacious as to admit of the exit of every individual in ten minutes, in a manner that would not injure an infant; that the whole of the stage being a vast tank of water, it was impossible that the engines behind the scenes should want a supply; besides the total absence of alarm in the countenances of the performers, it might be supposed sufficiently indicated, that the only place concealed from their view was entirely free from danger. The fears of those who sat in the back part of the gallery were far more justly excited; they saw nothing but the stage, and might suppose that the boxes or pit beneath them was on fire, and their own screams prevented their hearing the intreaties for silence from the stage; it is, therefore, not altogether to be wondered at that they endeavoured to escape.

Dr. Cogan very truly observes, that an idea is the grand exciting cause of every

passion and affection: it instigates the whole of our conduct; it pervades and directs every internal operation of the mind; it is clearly known by every one who has the power of thinking, but it defies every definition. That this is the truth no one will dispute: hence it appears, that the Divinity has given us an invisible active spirit, possessing the means of perception, and even of foresight, extending to a hint of what would be hurtful, or beneficial, or pleasant, on which it is intended reason, improved by education and experience, should act and bring to perfection.

Admitting these premises, it necessarily follows, that man has the means of foreseeing what will prove injurious, or the reverse, and the power of turning those means to the full use intended. These we shall term the control of the passions; were they carried to the extent of which they are capable, half the present unhappiness of life might be avoided, and an endless catalogue of dangers prevented.

We manage the horse, and command his passions; nay, we teach him to face the fire and thunder of cannon; though we know that, when untutored, his fears fascinate him to the spot where that element surrounds and would destroy him: shall it then be said that the infant must advance into life with all its passions advancing in equal proportion? have we reason given us to tutor the horse and neglect our own species? Surely not. Let the latter, then, be taught, in the earliest period of existence, to fear nothing but moral evil; let the child be led into the very jaws of danger, and taught the method of deliberate retreat, that he may not faint before shadows, and magnify fancies into gulfs of destruction.

Parents, nurses, and ignorant teachers, lay the foundation of much misery, by exciting fears of imaginary beings in the minds of infants. This method of frightening them into propriety of conduct turns the thoughts of the child from contemplating the appearance of natural objects, whose operations are easily comprehended, into a dark vacuum, where fancy finds floating spectres of horrid form and mein, which haunt them sleeping, and pursue them in the dark through the remainder of their lives; and to this cause we principally attribute the sudden magnifying of the soul's hints of danger, which finding nothing real to work upon, the thoughts are wrought into chaos and frenzy, confusing the organs of speech, depriving the muscles of the power of action, and sometimes the body of existence.

Fear operates in a variety of ways upon the human frame, and its effects depend, in a great measure, on the temperament of the body under its influence. Females, when suddenly and violently alarmed, frequently utter a piercing cry, and faint into total insensibility. Others are seized with hysterics, or a general convulsion of the whole system; and in slighter degrees of fear, the eyes are fixed on the object of terror, while the feet involuntarily perform the office of flight. When the cause of fear strikes the soul without a possibility of an intervening conception of it, an universal start of the nerves and muscles is the consequence; the contraction of the skin of the head raises the hair upright; the blood rushes back to the heart, which palpitates most rapidly; the mouth opens; the eyes undergo the same operation, and are stretched in eager gaze after the dreaded object; and an uniform trembling and faintness of the limbs take place. The best painters exhibit terrified figures with their arms extended forward, as if to resist an assault, or rather to prevent a substance from rushing against them; one of the legs set firmly back, the mouth open, the eyes glaring, the skin of the temple wrinkled, and a deadly paleness overspreading their features.

We shall support our observations on this first of the human passions by a short quotation from a late and approved writer. "Excessive fear is, by far, the most painful of all our sensations. Fear is wholly engaged in the contemplation of misery, which contains not a single particle in its nature calculated to soothe and mitigate its agonizing influence. But still it is the vigilant guardian of well-being. It tries every expedient, and makes every effort to escape the evil so much dreaded. Were we indifferent about things pernicious in themselves, they would frequently seize us totally unprepared, and overwhelm us when we might have escaped from them."

Fear may be generally attributed to an apprehension of we know not what calamity, one which may be traced to a cause, perhaps, but not to its full effects. Apprehension is a modification of the same passion, with sensations of uneasiness and restless watchings. Terror, on the contrary, has its cause in full view; the

eye sees it, the ear hears it, and the whole frame feels, by anticipation, the moment when it shall be crushed or overwhelmed by the approaching power. Consternation is a species of fear; a discovery is dreaded, which produces punishment, guilt causes agitation, and the emotions of consternation often occasion suspicion where none was entertained before. The indications of this passion are flushed and deranged features, hurried actions, and confused and contradictory speeches. Each of the above designations of passion apply to the universal desire entertained by man for his own preservation.

We shall next proceed to notice a passion equally destructive and pernicious in its effects upon the body, but far less innocent, anger, which is capable of being raised from a slight flushing of the face to furious rage. The discovery of an intended injury, a blow unexpectedly received, or insulting language, excite what is generally termed anger. Rage, on the contrary, more particularly proceeds from a reiteration of either of the above causes; such, at least, is anger founded on principles capable of some slight justification; but it must be admitted, that this passion is often generated by causes trivial and unimportant: difference of opinion in the course of common conversation, a dispute whether a window sash shall be opened or remain shut, have been known to produce anger, which could only be appeased by the shedding of blood. Passions arising from causes of this description, and indulged to excess, place human nature in a most degrading point of view, and exhibit the violence of self-love in the strongest colours. The soul in this instance gives the same warning of probable injury which takes place in the case of fear, with the difference of suggesting means of prevention. Anger braces the nerves, the muscles become rigid, and the body rises into a posture indicating majesty and defiance, the features are animated with a strong expression of energy, and the blood flows rapidly to the face.

Rage may be termed anger degenerated into the miserable state of insanity; in some instances the first impulses of rage are too powerful for the faculties, and the person under its influence either falls dead, or sinks into an agitation which disarms him of the power of resistance or defence; he becomes pale, and trembles from head to foot, and essays in vain to utter the purposes of his his soul; in others, where the constitution happens to be strong, the features are distorted, the muscles of the mouth are drawn back, the teeth grind together, the eyes are strained outwards, the brows are knit, the hands clenched, and every muscle indicates sudden exertion; the heart palpitates, and the lungs with difficulty afford air for respiration; so rapid are the cries and exclamations of the unhappy being thus moved, who becomes an object of compassion to the spectators, but out of pity, as it is more than probable that the vengeance about to be taken will be more than commensurate with the injury received.

Anger, in its slightest degree, necessarily follows certain occurrences, the consequences of family and social connections: and its indulgence is allowable under the guidance of reason, otherwise it would be impossible to correct the aggressions of unthinking persons, or conduct the education of youth; but beyond this boundary, it becomes brutal and degrading to our nature. Anger may be made habitual by indulgence; the nerves are, by this means, rendered diseased and irritable, and the person thus situated actually falls into an universal tremor, with a species of rage, almost at the instant the ear hears, or the eye views the cause of offence; indeed some cases exist, when the mind becomes inflamed at the bare suspicion of what may be said or done. Miserable are the feelings of those who suffer anger to overpower their reason, and miserable are the effects of their rapid and frequently unfounded conceptions. It may be doubted whether the mind, in this state of derangement, can be recovered to discrimination and gentleness in adults; it is, therefore, doubly necessary to repress any effervescence in the breasts of infants, who are known to feel most violent paroxisms of rage, even before their limbs are capable of supporting them, and which have been known to be fatal. This circumstance, alone, proves that our passions are received with life in their full vigour, consequently every means should be tried to soothe and repress them, rather than to encourage their increase, by teaching resentment against animals, friends, and inanimate objects, by the detestable practice of asking a blow from a child to beat a table or wainscot, for coming in contact with its head or limbs, or a person or animal for some offence. Revenge is a twin brother of anger or rage; we see but little of the

movements of this branch of the passions, as they are generally secret, founded on fear, and prey on the vitals of the wretch who entertains it; it is a compound of courage and apprehension, but the latter ever predominates. Revenge is not always confined to acts, but descends to malice, which delights in insinuations and false conclusions; when successful, the human face divine becomes the type of that of a fiend, and a smile sets on the features which cannot be described.

Another gradation of anger is hatred, which arises from a real or supposed injury. Inveterate hatred is a most direful passion, distorting every word and every act of the individual the subject of it; whose smiles are equally detested with their frowns, and whose motives in all cases are supposed to be governed by an intention of injuring the possessor of this unworthy sensation. Resentment is a far more generous inmate, because it possesses the power of discriminating an unintentional from a voluntary insult, and is vented generally, and immediately, in words alone. It must be obvious, that he who entertains hatred fosters an inmate which feeds upon his own vitals, even when the object hated is unconscious of its existence, or has forgot its future consequences.

Envy often produces hatred; the former being a most unreasonable passion, seems to derive its origin from an innate principle of evil; it is one, in short, which cannot be accounted for on any rational grounds. The person influenced by envy feels some deficiency, and observes another endowed with qualifications either beyond the reach of acquirement, or that may be obtained without difficulty; when the defect lies in the person or features, it might be imagined that the hopeless state of the case would produce resignation, if not content. If the acquirements disliked or envied are attainable by all mankind, emulation might be supposed to urge an attempt at rivalry: but, no; the envious person rests in listless inactivity, and suffers his mind to tear every ornament, natural or artificial, from the subject of his dislike, his eyes to express it, and his tongue to depreciate and lessen every movement of the involuntary enemy of his repose. Aversion is often produced by a similar cause; and yet it must be admitted, that aversions do sometimes occur in minds virtuous and pure, which require the strongest efforts to subdue them. Those, however, generally proceed from the contemplation of a set of forbidding features, or some peculiarity in the manners of the individual disapproved of, and may be conquered by exertion. In another sense, aversion is proper and justifiable; the good must feel an aversion for those whose conduct is wicked or disgraceful.

Hatred is expressed by contemptuous looks, or knitting of the brows, the raising of the lips towards the nostrils, and an averted face. Envy exhibits an eagerness to see the departure of its object, when the eyes sparkle, and the voice is tuned to ridicule. Aversion shuns the presence of the wicked, and turns the back to its presumptuous folly.

Cruelty, this perversion of our nature, for it cannot be innate, may be traced to its origin without a circuitous or theoretical process. Examine the domestic economy of most families, and the result will be, that five out of six who have infants to instruct and educate possess some animals, entertained for the sole purpose of amusing the tender years of their offspring, which are dragged by the neck and limbs from one to another, with the same indifference in the child and parents, and their attendants, as if they were inanimate representations of dogs, cats, rabbits, or birds; and should the injured animal complain or resist, the family is in arms to beat, nay, hang the innocent offender, while the child is soothed with execrations of the animal, and assurances of a cruel revenge. Can the unfortunate being thus tutored be supposed to respect the feelings of man, when opposed to his will, in the course of his future life, after having been taught to despise the cries of suffering from his earliest days? Impossible. To follow the aberrations of so hateful a disposition would require a relation of facts which are calculated to excite horror, as the exercise of it extends into a variety of acts, decidedly opposite to each other in their motives. Instances have been known of the infliction of tortures, both mental and corporeal, which could not be traced to any rational cause: when it arises from revenge against real or imagined injuries, we are not at a loss for the reason why a wretch should exult in the misery of his victim; but it is shocking to reflect on the conduct of a fiend, who, after robbing an unresisting traveller, beats him almost to death. In this case, and in those cruelties frequently exercised on the brute creation, we find such a total rejection of the man-

ly dignity of the human race, that we are almost inclined to hope the inflictors are a race of evil spirits, distinct and separate from us.

The indulgence of any of the preceding passions may lead to cruelty: even the coward indulges in this propensity when he can get his enemy into his power with safety to himself. But cruelty is not merely confined to bodily suffering; a person may be violently cruel by words, insinuations, and suggestions, that will for ever destroy the peace of individuals and families: those may be classed under the terms prejudice and censoriousness: the former is a perverse determination to resist every attempt at conciliation, where offence has been given, and to confute every assertion in favour of the victim by falsehoods and prevarication; the latter will suffer nothing in the conduct of his enemy to be correct and proper; he censures each act and each word at every opportunity; and surely nothing can be more unjustifiable and cruel. Desire is a natural but uneasy sensation of the mind; in one point of view it is a necessary means for the support of the human species, and in others it may be commendable and exactly the reverse. The desire to injure either in person or property is criminal, but a desire to effect any commendable purpose deserves all possible encouragement.

Among the minor affections of the mind which are vicious, though not decidedly criminal, we must include peevishness or ill-nature. The person under the influence of this miserable feeling is seldom mischievous, as all his friends and associates are included in his fretful comments, and their general tendency disarms them of their sting. We read the state of his soul in the half angry, half sorrowful, turn of his features: and we are inclined to pity him as under the influence of an incurable disease: and, in truth, peevishness often proceeds from a morbid affection of the body.

Ingratitude is a species of apathy: he that receives a benefit, and is not grateful in return, must possess an insensibility or apathy by no means to be envied. The latter term, indeed, seems to imply a total absence of feeling and passion, or a faculty of seeing and hearing every occurrence unmoved. It may, however, admit of a doubt, whether the appearance of apathy is not to be traced to a perfect command of the external actions of the features and limbs, which disguise the agitation of the mind to the common observer, at the same time that nature performs her operations in the soul without effectual obstruction.

There are other designations of the intemperate passions, or those which injure us in the present state of society, and will certainly produce punishment; but as they all refer, in some degree, to those already noticed, we shall turn our attention to a more pleasing portion of the subject. The benevolence of the Creator towards mankind has been demonstrated by the most unequivocal proofs. This cannot be disputed or doubted for a moment, when it is remembered, that the first operation of the infant mind is love. The infant recognises its parent, and smiles with inexpressible delight upon her face; the smile is returned with tenfold interest, and thus commences life and the passions. Were this fact held in constant recollection, the latter would be kept in just subordination, instead of being encouraged to defeat the intentions of the divinity.

Upon examining the features of a handsome child a few weeks after its birth, when in the act of fondling its mother, and that of the latter at the same instant, it will be found that nature has made the human species in a most exquisite mould indeed. On one hand, perfect innocence has full possession of the face; on the other, recent illness, a disregard of external affairs, and present happiness, has restored perfect content. Exquisite picture of perfection! how much is it to be regretted, that perverseness has made it transient. Encouraged as these our first propensities sometimes are, we find the parent attentive and anxious, instructing with eagerness, correcting with gentleness; the offspring venerating, admiring, and emulating; and all is happiness, complacency, and content. Placid and regular lines throughout the countenance point out those happy mortals for imitation, the muscles are never strained and distorted, and the painter is at a loss how to express the repose and benevolence he essays to copy.

Love, in another sense, descends one step from the above exalted station, and becomes difficult to be defined. Youth frequently feel a passion for their opposite sexes, founded upon an inexplicable emotion of the soul, which seems blinded, and incapable of discrimination. In this case it is an impulse without stability, as it frequently happens that the gra-

tification of the impelling power proves absurd and injurious; from which it appears, that love should, in the first instance, be received merely as a hint, the propriety or impropriety of which is to be examined by the test of reason, and cherished or rejected according to her dictates. Love, thus confirmed, is a blessing to the possessor, as it induces the exercise of every amiable quality towards its object, consequently, harmonizing and reconciling the soul to independent occurrences. The sensations of this passion are so tranquil, that the features are but little affected; the eyes sparkle with vivacity, when directed to the person admired, the mouth gently opens, and a serene smile is the only indication of influence on the muscles.

Hope necessarily arises from the indulgence of love, but it is a faithful attendant of every other passion; consequently, it sometimes becomes criminal. Hope is a compound of fear and desire. The person under the influence of this companion of every situation in life fixes his affections or desires upon the attainment of some favourite object or pursuit, and his mind experiences the alternate pleasures and pains of fruition and disappointment, as the prospect of attainment or want of success predominates. Indeed, every individual may be said to exist from their infancy in hope; and we all die in hope of future happiness, though the hopes of our lives have too often been directed to the very means of punishment, veiled under the specious appearance of probable felicity. Hope and expectation have the same effect upon the frame and features; the heart palpitates, the countenance is enlivened by a display of eagerness and search for something invisible.

Joy is the result of success in this aggregate of self love, which is a passion, in some instances, too violent for the strength, and death or madness, and fainting, succeed, when it takes place before the mind has been prepared to receive it. The most extravagant and frantic actions distinguish those whose animal spirits are in full vigour, and under little control, when it takes sudden effect; and it is, therefore, absolutely necessary to inform such persons gradually of the benefit or advantages they are about to experience. Unutterable pleasure dances in the features of those less agitated: they skip and leap from place to place, laugh, recount rapidly prospects of future happiness and intentions, and have been known to melt into tears. Such are the consequences of immediate relief from impending danger, apprehended personally or for friends, and extrication from pecuniary difficulties. Happiness is the tranquil attendant of joy, but never assumes the sway till all the turbulent emotions are subsided: then, indeed, the contemplation of future good produces an ecstatic sensation, which gradually passes into gladness, contentment, and satisfaction, the repose and completion of joy.

Pride is one of the class of improper passions, when indulged as the result of some imaginary perfection; but a consciousness of superior worth, which renders the possesor too proud to act or say any thing derogatory to the honour of his rank and connections, is the only justifiable pride. The male or female, proud of birth, of riches, elegance of person, and those who are proud without any of the advantages enumerated, are equally ridiculous and contemptible; such unfortunate self-tormentors are jealous of every occurrence, lest it should, in its consequences, trench upon their own importance; they see and hear disrespect in every movement and every sound that is uttered, and, full of alarmed dignity, the features are contracted into a contemptuous threatening frown, the head is thrown backward, the steps are measured, the hand waved, and they stalk into retirement, where a thousand stinging malicious reflections accompany and make them miserable.

Vanity is a near relative of pride; but this affection of the soul is generally, though not always, personal. They who are fortunate enough to possess superior attractions of body and features, cannot but be conscious of their claims to admiration, which are willingly answered by the public, when humility and modesty attend them; but vanity no sooner attempts to point them out by the ridiculous arts of dress, and disposition of countenance and limbs, than envy commences her operations, and contrives to excite laughter instead of applause. Richness of the habit, affected smiles to shew a fine set of teeth, and a strutting mode of walking, are sure marks of vanity.

Modesty, the direct opposite of pride and vanity, is sometimes carried to excess. The natural and acquired advantages we possess ought ever to give a tempered consequence to the front and mein. The really modest person often sinks into bashfulness, which is a most troublesome though not a vicious companion. To shrink from view and con-

ceal our attainments is unjust to our instructors; besides, example is required in society. Modesty and bashfulness occasion apprehension and trembling, and deep blushes and hesitation in speech complete the confusion and errors committed.

We have hitherto treated on those passions which agitate the mind and body in various ways, without melting the soul into what is termed sorrow, and its numerous ramifications. It is difficult to separate any of the sensations under this head from the affection of self-love, though it is beyond a doubt that much really disinterested sorrow is felt. Grief is the most violent emotion experienced by man, and the most difficult to conquer. An injury may be forgiven, an enemy converted into a friend, and resentment subdued; but grief seizes upon the soul after the loss of a relative with irresistible power, and reason exerts herself in vain to shake it off. The moralist argues against its indulgence without effect, because the loss cannot be supplied, and the mind is compelled to wander in a desert, where it searches in vain for its departed friend. Grief sometimes affects the faculties even to derangement, and produces melancholy madness, which of all the varieties of insanity is the most hopeless. In cases of this nature the organs of life are obstructed, the heart oppressed, the lungs are inflated almost to bursting, deep sighs are essayed for relief, but in vain; a sudden obstruction recurs in the windpipe, and that part of the body seems more affected than any other. The unhappy sufferers wander, lost in misery, from place to place, wring their hands, and strike their feet forcibly on the ground; raise their eyes, as if in silent ejaculation, and the muscles of their mouths are drawn down, giving the countenance the expression of dreadful agony. It is this state which is the most alarming for the safety of the senses; when tears and lamentation succeed, immediate relief is experienced, and time will produce settled sorrow.

This is attended by a composure of features more affecting to the spectator than the most vehement paroxysms of grief. The afflicted person seeks retirement to weep, loses his appetite, is careless of his dress, and views the grave and the gay with equal indifference, and, when in this state, incurs the danger of falling into an habitual melancholy, which, though often the result of the loss of friends, is not less frequently the consequence of disease. The melancholy man feels an universal listlessness; he is deprived of all desire of exertion, walks without consciousness, and reposes his limbs when fatigued by the mere impulse of nature. As it appears, his mind is abstracted from all external objects, and preys only upon itself, the brilliancy of the sun, the beauty of the expanse of air and clouds, the pride of the spring, and the rigour of winter, pass in their fascinating varieties before him unnoticed, and he is only anxious to escape from them by suicide.

Resignation is one remove towards returning happiness, the calmness and tranquility of which cannot be described; but it is nearly allied to humility, or a sense that no exertion will avail to restore the loss occasioned by death, and that it is little short of presumption to oppose the weakness of human nature to the dispensations of Providence. Humility, however, bears another character, and becomes in this view a melancholy resignation, or acquiescence in the consciousness of some defect of person or intellect.

Enthusiasm, or vehemence, in any pursuit may be called a passion of the soul, which exhibits its effects with the greatest violence when generated by religion. To describe its consequences would require a volume. It has led, and will hereafter lead, mankind into a thousand extravagancies, which can only be compared with the inconsistencies of madness. This cause will impel him to flagellate the body till blood follows, immure himself within a voluntary prison, and to meet death in any shape it may present itself. The consequences of this passion cannot well be described, as they belong almost decidedly to disease. Enthusiasm is the parent of despair, which it frequently produces in the minds of those who conceive that their sins in this life exceed the possibility of future forgiveness. The wretch thus situated displays all the gestures and actions of grief united with terror, a compound which is fortunately generally concealed from view by the asylums for lunatics.

We have now noticed the principal emotions of the soul, and stated our opinion that the causes of them are studiously kept from us by the great Author of that ethereal spirit; and without attempting to reason upon the probability or improbability of the opinions of others, we shall conclude this article with a slight summary of some of them.

PASSION.

Writers on the passions have indulged in a variety of speculations and conjectures as to the precise situation of their impetus, in hopes of ascertaining whether that is in the material animated part of man, or in the spiritual. Des Cartes and other philosophers will have their seat to be wholly in the corporeal system; and Mr. Grove, of a totally opposite opinion, concludes the passions to be "the affections attended with peculiar and extraordinary motions of the animal spirits;" and adds, that he inclines to "think that a sensation of the soul generally precedes a change in the spirits, external objects not being able to raise a ferment in the spirits till they have first struck the mind with an idea of something noble, frightful, amiable," &c. Mallebranche defines the passions as being all those agitations of the soul, naturally proceeding from uncommon influence and motion in the blood and animal spirits; those he contrasts with others which are usual with decided intelligences, and which he terms natural inclinations.

Dr. Cheyne considered the passions in two points of view, spiritual and animal; the former he supposes to be the emotion produced in the soul by external objects, which become compounded and material by the intervention of the organs of life. The animal he defines by those effects produced by bodies or spirits immediately on the body. Dr. Morgan, by indefatigable observation, drew the following conclusion: "That all the grateful or pleasurable passions raise the vital tide, strengthen and quicken the pulse, diffuse the natural heat, and take off any antecedent stimulus or pressure upon the abdomen and inferior organs. And, on the contrary, the painful passions sink and depress the blood, weaken the pulse, recal and concenter the natural heat, and fix a stimulus, or compression, on the inferior organs. All the passions impress their characteristic sensations or modifications on the muscles of the larynx, and thus discover themselves by the different modulation and tone of the voice." From which he concludes, that the nerves of the eighth conjugation, or *par vagum*, are the principal instruments of the passions.

Dr. Reid doubts whether the "principle of esteem as well as gratitude ought to be reckoned in the order of animal principles, or if they ought not rather to be placed in a higher order." The same author, treating on resentment, has considered it as a sudden and instinctive animal principle, common to the brute creation and mankind; at the same time he calls deliberate resentment a rational principle.

To pursue theories further would be useless, we shall therefore conclude with the opinion of Dr. Cogan, one of the latest writers on the subject: "Without entering therefore into enquiries of this nature, which for want of data must be conjectural and unsatisfactory, it will be more consistent with my plan, simply to state interesting facts, and leave it to the metaphysician to draw such consequences as he may deem most legitimate. It must be admitted that every passion, emotion, and affection proceeds from certain impressions or ideas excited concerning the nature, or state, or quality, or agency of the exciting cause. These ideas have undoubtedly their seat in that part of man we distinguish by the appellation of mind." This admitted, the Doctor advances, that the exciting cause must change the state of it in relation to any given object; thus from total indifference the mind becomes in some particular manner interested, consequently the new impression produces a correspondent change upon the body, and in proportion to the impetus, general observation, and universal phraseology founded upon that observation, demonstrates that a perceptible influence of each violent emotion is directed towards the heart, which feels different sensations, pleasant, or the reverse, over which it has no controul, and from this centre diverges the influence of agitated spirits, the slightest effects of which are not visible to the spectator. "Nay," adds this gentleman, "the subject himself is not conscious perhaps of any thing more than either a change of sentiment on the perception of the stronger influence of a former sentiment connecting with something agreeable or disagreeable in this perception; a something which attaches more strongly to the object, or creates some degree of repugnance. This state of mind is styled an affection, and it appears to be totally mental; but stronger influences produce such changes, that the inward disposition becomes obvious to the spectator, through the medium of the corporeal frame. It is now called an emotion, and this may increase in strength until the whole system becomes agitated and convulsed. From this statement it appears incontestible, that the affections and passions have their origin in the mind, while emo-

tions are corporeal indications of what passes within."

PASSION, or *Cross of the Passion*, in heraldry, is so called, because resembling the shape of that on which our Saviour is thought to have suffered; that is, not crossed in the middle, but a little below the top, with arms short in proportion to the length of the shaft.

PASSION *flower*, in botany. See PASSIFLORA.

PASSPORT, is a license for the safe passage of any person from one port to another.

PASTE, a composition of water and flour, boiled to a consistence; used by various artificers, as saddlers, upholsterers, book-binders, &c.

PASTE, in the glass trade, a kind of coloured glass, made of calcined crystal, lead, and other metallic preparations, so as to imitate the natural gems. The basis of these compositions is a pure glass, prepared from pounded quartz, fused with alkali, with the addition of borax and of oxide of lead. The latter gives density to the glass, a susceptibility of receiving a higher polish, and a greater refractive power, by which the lustre is increased. Different colours are obtained by the addition of various metallic oxides. The oxide of gold gives a red; of cobalt, blue; of manganese, purple; of lead, yellow; and of iron, green: and these colours are so rich, as to be equal, or even superior, to those of natural gems, though in lustre, hardness, and durability, the pastes are far inferior. They may be distinguished by their inferior specific gravity, and their softness, which is such that they can be scratched by the knife.

PASTEBOARD, a kind of thick paper, formed of several sheets of paper pasted together. The chief use of pasteboard is in binding books, making letter-cases, &c. See PAPER.

PASTINACA, in botany, *parsnip*, a genus of the Pentandria Dyginia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit elliptic, compressed, flat; petals involute, entire. There are three species; of which P. sativa, common garden parsnip, has smooth leaves, of a light or yellowish green colour, in which it differs from the wild plant; the stalks also rise higher, and are deeper channeled; the peduncles are much longer, and the flowers of a deeper yellow colour. The roots are sweeter than carrots, and are eaten by those who abstain from animal food in Lent, or eat salt fish: they are highly nutricious. In the north of Ireland they are brewed, instead of malt, with hops, and fermented with yeast; the liquor thus obtained is very agreeable.

PASTORAL, in general, something that relates to shepherds; hence we say, pastoral life, manners, poetry, &c. The original of poetry is ascribed to that age which succeeded the creation of the world; and as the keeping of flocks seems to have been the first employment of mankind, the most ancient sort of poetry was probably pastoral. It is natural to imagine, that the leisure of those ancient shepherds admitting and inviting some diversion, none was so proper to that solitary and sedentary life as singing, and that in their songs they took occasion to celebrate their own felicity. From hence a poem was invented, and afterwards improved to a perfect image of that happy time, which, by giving us an esteem for the virtues of a former age, might recommend them to the present. And since the life of shepherds was attended with more tranquillity than any other rural employment, the poets chose to introduce their persons, from whom it received the name of pastoral. A pastoral is an imitation of the action of a shepherd, or one considered under that character. The form of this imitation is dramatic, or narrative, or mixed with both; the fable simple; the manners not too polite nor too rustic; the thoughts are plain, yet admit a little quickness and passion, but that short and flowing; the expression humble, yet as pure as the language will afford; neat, but not florid; easy, and yet lively. In short, the fable, manners, thoughts, and expressions, are full of the greatest simplicity in nature. The complete character of this poem consists in simplicity, brevity, and delicacy; the two first of which render an eclogue natural, and the last delightful.

PASTURE, is generally any place where cattle may feed, and in law is mostly applied to a common of pasture, or right of feeding cattle on certain waste lands. See COMMON.

PATE, in fortification, a kind of platform, resembling what is called an horseshoe; not always regular, but generally oval, encompassed only with a parapet, and having nothing to flank it. It is usually raised on marshy grounds, to cover the gate of a place.

PATEE, or PATTEE, in heraldry, a cross, small in the centre, and widen-

ing to the extremes, which are very broad.

PATELLA, in anatomy, a bone which covers the fore-part of the joint of the knee, called also rotula, and popularly the kneepan.

Patella, in natural history, *limpet*, a genus of the Vermes Testacea: animal a limax: shell univalve, subconic, shaped like a bason; without a spine. This is a very numerous genus, containing between two and three hundred species, divided into sections. A. Furnished with an internal lip; shell entire. B. With the margin angular, or irregularly toothed. C. With a pointed, recurved tip or crown. D. Very entire, and not pointed at the tip or crown. E. With the crown or tip perforated. The most worthy of notice are the following: P. vulgata, of Europe, with rough prominent striæ, and sharply crenated edges; vertex pretty near the centre; the edges often in old subjects are almost smooth. P. pellucida, with a transparent shell, marked longitudinally with rows of rich blue spots: the vertex placed near one edge; inhabits the sea rocks of Cornwall, England. P. græca, with an oblong shell, perforated vertex, striated roughly to the edges. It inhabits the west of England. This genus was well known to the ancient Greeks, from whom we learn that it was used for the table, and that it was found adhering to the rocks.

PATENT, something that stands open or expanded; thus a leaf is said to be patent when it stands nearly at right angles with the stalk.

Patent, or *Letters Patent*, are writings sealed with the great seal of England, by which a man is authorized to do, or to enjoy, any thing, which of himself he could not. They are so called on account of their form, being open, with their seal affixed, ready to be exhibited for the confirmation of the authority delegated by them. Letters patent for new inventions are obtained by petitions to the crown: they go through many offices, and are liable to opposition, on account of the want of novelty, &c. and if obtained, and it can be proved that the invention was not new, or had been made public previously to the granting the patent, they may be set aside. A patent, at the lowest cost, and when no opposition is given to it, will, for fees of office, specification, &c. cost for the three branches of the United Kingdom about three hundred pounds.

PATRIOT, "a sincere and unbiassed friend to his country; an advocate for general civilization, uniting in his conduct through life moral rectitude with political integrity. Such a character is seldom found in any country; but the specious appearance of it is to be seen every where, most especially in Europe. It is difficult to say how far the term can be used in a military sense, although it is not uncommon to read of a 'citizen soldier,' and a 'patriot soldier.' Individually considered, the term may be just, but it is hardly to be understood collectively. A celebrated English writer has left a treatise, intituled, "The Patriot King; by which he means the first magistrate of a country who acts up to the genuine principles of its constitution. It is devoutly to be wished, (human nature being so constituted as to require coercion) that the application of military force could always be in the hands of a patriot king, who is the first soldier in the land, and would of course be entitled to the appellation of a patriot soldier. The convulsed state of Europe is such, that no country can do without soldiers. When they are employed to defend, or protect their native land, they are patriot soldiers." See James's Military Dictionary.

PATROL, in war, a round or march made by the guards, or watch, in the night-time, to observe what passes in the streets, and to secure the peace and tranquillity of a city or camp. The patrol generally consists of a body of five or six men, detached from a body on guard, and commanded by a serjeant. Patrols are formed out of the infantry, as well as the cavalry. When a weak place is besieged, and there is reason to apprehend an assault, strong patrols are ordered to do duty; those on foot keep a good look out from the ramparts, and those that are mounted take care of the outworks.

PATRON, both in the canon and common law, signifies him that hath the gift of a benefice or parsonage.

PATRONYMIC, among grammarians, is applied to such names of men and women as are derived from those of parents or ancestors. Patronymics are derived, 1. From the father, as Pelides, *i. e.* Achilles, the son of Peleus. 2. From the mother, as Philyrides, *i. e.* Chiron, the son of Philyra. 3. From the grandfather on the father's side, as Æacides, *i. e.* Achilles, the grandson of Æacus. 4. From the grandfather by the mother's side, as Atlantiades, *i. e.* Mercury, the

grandson of Atlas: and, 5. From kings and founders of nations, as Romulidæ, *i. e.* the Romans, from their founder, King Romulus.

PAVEMENT, a layer of stone, or other matter, serving to cover and strengthen the ground of divers places for the more commodious walking on. In London the pavement for coach-ways is chiefly a kind of granite from Scotland: and on the footpath Yorkshire paving is used; courts, stables, kitchens, halls, churches, &c. are paved usually with tiles, bricks, flags, or fire-stones; and sometimes with a kind of free-stone and rag-stone. In France, the public roads, streets, courts, &c. are paved with gres, a kind of free-stone. In Venice, the streets, &c. are paved with brick; churches sometimes with marble, and sometimes with Mosaic work. In Amsterdam, and the chief cities of Holland, they call their brick pavement the burgomaster's pavement, to distinguish it from the stone or flint pavement, which is usually in the middle of the street, serving for the passage of their horses, carts, coaches, and other carriages; the brick borders being designed for the passage of people on foot. Pavements of free-stone, flints, and flags, in streets, &c. are laid dry, that is, are retained in a bed of sand; those of courts, stables, ground-rooms, &c. are laid in mortar of lime and sand, or in lime and cement, especially if there be vaults or cellars underneath. Some masons, after laying a floor dry, especially of brick, spread a thin mortar over it, sweeping it backwards and forwards, to fill up the joints. Thirty-two statute bricks, laid flat, pave a yard square; sixty-four edgewise. The square tiles used in paving, called paving bricks, are of various sizes, from six to twelve inches square. Pavements of churches, &c. frequently consist of stones of different colours, chiefly black and white, and of several forms, but chiefly square and lozenges, artfully disposed.

Pavement *of terrace*, is that which serves for the covering of a platform, whether it be over a vault, or on a wooden floor. Those over vaults are usually stones squared, and bedded in lead. Those on wood are either stones with beds, for bridges; tiles, for ceilings in rooms; or lays of mortar, made of cement and lime, with flints or bricks laid flat, as is still practised by people in the east and south, on the tops of their houses.

PAVETTA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Stellatæ. Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form, superior; stigma curved; berry two-seeded. There are seven species.

PAVILION is sometimes applied to flags, colours, ensigns, standards, banners, &c. See Flag, &c.

Pavilion, in heraldry, denotes a covering in form of a tent, which invests or wraps up the armories of divers kings and sovereigns, depending only on God and their sword. The pavilion consists of two parts; the top, which is the chapeau, or coronet; and the curtin, which makes the mantle. None but sovereign monarchs, according to the French heralds, may bear the pavilion entire, and in all its parts. Those who are elective, or have any dependance, say the heralds, must take off the head, and retain nothing but the curtins.

PAULLINIA, in botany, a genus of the Octandria Trigynia class and order. Natural order of Trihilatæ. Sapindi, Jussieu. Essential character: calyx five-leaved; petals four; nectary four-leaved, unequal; capsules three, compressed, membranaceous, connate. There are seventeen species, all natives of warm climates.

PAVO, the *peacock*, in natural history, a genus of birds of the order Gallina. Generic character: bill convex and strong; head covered with turned-back feathers; nostrils large, feathers of the tail long, broad, expansile, and adorned with rich eye-like spots. There are four species. The P. cristatus, or crested peacock, was originally brought from India, where it is found in its wild state, and exhibits all its maturity of growth, and glow of colouring. It was an article of importation from that country to Palestine, in the reign of Solomon, in those fleets which conveyed once in three years, to the court of that magnificent monarch, invaluable treasures of art and nature. In this country, peacocks do not attain their full and brilliant plumage till their third year. The female lays five eggs, and is particularly solicitous to conceal them from the male, which not unfrequently destroys them. These birds feed almost solely on insects and grain. They prefer elevated situations for roosting, choosing the tops of houses and the highest trees for this purpose. They were considered as luxuries for the table by the Romans, and the young ones are now regarded as a delicacy. Their voice is harsh and dissonant,

and in perfect contrast to that beauty exhibited by their plumage, which, in the language of Buffon, "seems to combine all that delights the eye in the soft and delicate tints of the finest flowers, all that dazzles in the sparkling lustre of the gem, and all that astonishes in the grand display of the rainbow." See Aves, Plate XI. fig. 2.

PAUSE, a stop or cessation of speaking, singing, playing, or the like. The use of pointing, in grammar, is to make proper pauses in certain places. There is a pause in the middle of each verse; in an hemistich it is called a rest or repose.

Pause, in music, a character of silence, or rest, called also by some a mute figure, because it shews that some part or person is to be silent, while the rest continue the song. Pauses are used either for the sake of some fugue, or imitation, or to give a breathing time; or to give room for another voice, &c. to answer what this part sung, as in dialogues, echoes, &c. In military affairs it is essentially necessary for all officers to accustom themselves to a most minute observance of the several pauses which are prescribed during the firings. According to the regulations, the pause between each of the firing words, "make ready, present, fire," is the same as the ordinary time, *viz.* the seventy-fifth part of a minute, and no other pause is to be made between the words. In firing by companies, by wings, each wing carries on its fire independently, without regard to the other wing, whether it fires from the centre to the flanks, or from the flanks to the centre. If there are five companies in the wing, two pauses will be made between the fire of each, and the make ready of the succeeding one. If there are four companies in the wing, three pauses will be made betwixt the fire of each, and the make ready of the succeeding one. This will allow sufficient time for the first company to have again loaded, and shouldered at the time the last company fires, and will establish proper intervals between each. In firing by grand divisions, three pauses will be made between the fire of each division, and the make ready of the succeeding one. In firing by wings, one wing will make ready the instant the other is shouldering. The commanding officer of the battalion fires the wings. In firing companies by files, each company fires independently. When the right file presents, the next makes ready, and so on. After the first fire, each man as he loads comes to the recover, and the file again fires without waiting for any other; the rear rank men are to have their eyes on their front rank men, and be guided by, and present with them.

PAUSUS, in natural history, a genus of insects of the order Coleoptera. Antennæ two-jointed, the upper joint very large, inflected, hooked, pedicillate; head pointing forwards, with a convex, jugular triangle; thorax narrow, unequal, scutellate; shells flexile, deflected, truncate; four feet placed at the fore part of the breast, thighs with minute appendages; tarsi four-jointed. There are five species; two of which are fully described in the "Linnæan Transactions," vol. 4. P. microcephalus, head unarmed; club an oblong sphere; shells as long as the body, not punctured; shanks linear. It inhabits the Banana islands. P. sphœrocerus: head horned; club globular: shells shorter than the abdomen, punctured; shanks dilated at the tip. It is found at Sierra Leone; wanders about in the night-time during the months of January and February, and becomes blind or benumbed on the approach of light; the globes of the antennæ give a kind of phosphoric light in the dark; the body is polished, and of chesnut colour, a little narrower than the last; horn between the eyes straight, conic, tipped with a tuft of cartilaginous hairs; eyes larger; thorax the same breadth as the head; wings shining and violet.

This genus is remarkable for the singular conformation of its antennæ, and for the almost prophetic anticipation of the future, under which it received its name. The great Swedish naturalist, foreseeing the termination of his vast labours, and that he would not again be called upon to form any other genus of insects, applied to this the designation which it now bears, "Pausus," signifying a pause or rest; it was in reality the last genus he formed, and it is believed that the species of it with which he was acquainted were amongst the last insects, if not the very last, which he described

PAW, *patte*, in heraldry, the fore foot of a beast, cut off short. If the leg be cut off, it is called gambe. Lions paws are much used in armory.

PAWLE, in a ship, a small piece of iron bolted to one end of the beams of the deck close to the capstan; but yet so easily, as that it can turn about. Its use is to stop the capstan from turning back, by being made to catch hold of the

whelps; they therefore say, heave a pawle; that is, heave a little more, for the pawle to get hold of the whelps: and this they call pawling the capstan.

PAWN, among miners, a pledge put into the bar-master's hand, at the time when the plaintiff causes the bar master to arrest the mine.

PAWNBROKER. See BROKER.

PAY, in the sea-language. The seamen say, pay more cable, when they mean to let out more cable.

PAYING, among seamen. When the seams of a ship are laid over with a coat of hot pitch, it is called paying her; and when this is done with canvass, parcelling; also when, after she is graved, and the soil burned off, a new coat of tallow and soap, or one of train oil, rosin, and brimstone boiled together, is put on her, that is also called paying of a ship.

PAYMENT, in law, is the consideration or purchase-money for goods, and may be made by the buyer giving to the seller the price agreed upon, either by bill or note, or by money. Where a day certain is appointed for payment, the party bound shall be allowed till the last moment of the day to pay it in, if it be an inland bill. Payment of money before the day, is, in law, payment at the day; for it cannot, in presumption of law, be any prejudice to him to whom the payment is made, to have his money before the time; and it appears by the party's receipt of it, that it is for his own advantage to receive it then.

PEACE has been represented, allegorically, as a beautiful female, holding in her hand a wand or rod towards the earth, over a hideous serpent, and keeping her other hand over her face, as unwilling to behold strife or war. By some painters she has been represented holding in one hand an olive branch, and leading a lamb and a wolf yoked by their necks in the other; others again have delineated her with an olive branch in her right hand, and a cornucopia, or horn of plenty, in her left. At Rome a celebrated temple was erected for the goddess of peace, which was furnished with most of the rich vases and curiosities taken out of the Temple at Jerusalem. The Temple of Peace, built by Vespasian, was three hundred feet long, and two hundred feet broad. Josephus says, that all the rarities which men are accustomed to travel to see, were deposited in this temple.

PEACE, in law, signifies a quiet and harmless behaviour towards the King and his people. The King, by his office and dignity royal, is the principal conservator of the peace within all his dominions; and may give authority to any other to see the peace kept, and to punish such as break it; hence it is usually called the King's peace. All the great officers of state are generally conservators of the peace throughout the kingdom, and may commit all breakers of it, or bind them in recognizance to keep it. Also the sheriff, coroner, constables, and tithingmen, are conservators of the peace within their own jurisdiction, and may apprehend all breakers of the peace, and commit them till they find sureties to keep the peace.

PEACH, in botany. See AMYGDALUS.

PEACOCK. See PAVO.

PEARL, a concretion formed in several species of shells, as in some species of the oyster and the muscle. It has been regarded by some persons as a morbid concretion, owing to an excess of shelly matter, and by others it is supposed to have originated in a wound of the shell containing the animal. Pearls are of a silvery or blueish-white colour, and very brilliant. As they consist of concentric layers of carbonate of lime and membrane, alternately arranged, the refraction of light is ascribed to the lamellated structure. See SHELL.

PEARL, *mother of*, is the shell, not of the pearl oyster, but of another sea-fish of the oyster kind. This shell on the inside is extremely smooth, and of the whiteness and water of pearl itself; and it has the same lustre on the outside, after the first laminæ or scales have been cleared off with aquafortis and the lapidary's mill. Mother of pearl is used in inlaid works, and in several toys, as snuff-boxes, &c.

PEARL, in heraldry, in blazoning with precious stones, is the same with argent, or white.

PEARL *ash*, an alkali used in various manufacturing processes: it is potash mixed with different heterogeneous substances, See POTASH.

PEARL *fishery*. The most important fishery to England at present is that at Ceylon. The origin of this method of procuring a valuable ornament for the person must have arisen from accidentally discovering the pearl within oysters taken for food is evident; but it is impossible to ascertain when the search became systematical, though it is extremely probable it has been so for many ages.

The pearl oysters of the coast of Ceylon are all of one species, and possess the same regularity of form; but they assume different qualities, and have different de-

nominations, suited to the nature of the ground where they are situated, and from the appearance of zoophytes adhering to the external surface of their shells. They resemble a cockle in shape, which is an imperfect oval, and their circumference is generally about nine inches and a half, having a segment as it were cut off where the joint of the two shells occurs. The interior of those is far more brilliant and beautiful than the pearl they enclose, and the outside is smooth, except when injured by the usurpations of sponges, corals, and other marine productions. The flesh of the animal is white, and of a glutinous consistency.

Perhaps no class of animated nature undergoes more unmerited persecution and destruction than the pearl-oyster; when situated in their native regions, they afford a foundation for the habitations of other animals, and millions of them are dragged from their banks, and thrown away, for what they are vainly supposed to contain, and that an intruder or a disease. One of the banks at Ceylon furnishes oysters to which zoophytes are attached, apparently belonging to the class of sponges, and those generally resemble a funnel or cup, and grow to a size that completely overshadows the oyster: others of different banks have a substance adhering to them tinged with red. The above are found to contain the finest pearls: some escape free from incumbrance, and thousands are compelled to bear trees of coral on them of five times their own weight.

The oyster is fastened to the rocks at the bottom of the sea by quantities of hairy fibres. By this means they are not readily swept from their original station, and yet possess the advantage of being conveyed to some distance from it by the motion of the water; besides, they are connected to each other in the same manner. It frequently happens that an old oyster, surrounded by young ones, is brought up by the divers, and the latter have been ascertained to possess, even when little larger than a grain of sand, the power of moving themselves by the extension and contraction of what is termed the beard. The violence of the waves at the time of the monsoons occasions great changes in the state of the banks, when incredible numbers of them are buried by the shifting of sand, and that is sometimes removed by the same power acting in a contrary direction.

It is supposed, from many concurring circumstances, that the pearl-oyster arrives at maturity at the close of seven years: after this period it is imagined that it dies, when the body decaying is washed away by the sea: a bed was discovered a few years since composed almost wholly of empty shells. The precious substance, which invites the exertions of man to obtain it, has been generally supposed to be a disease peculiar to the animal; but were this the fact, it is extremely prevalent amongst this description of oysters, as every individual of the species is found to be accompanied by a certain proportion of minute particles, which are evidently the pearl in the first stages of formation; hence it may be fairly supposed, that they are in some essential degree useful, rather than prejudicial to the inhabitant of the shells, of the nature of which it decidedly partakes, and is composed of a number of layers, moveable by a skilful person to the improvement of the pearl, as it sometimes happens the exterior coat only may be discoloured or injured. When the pearl is in a state of perfection, they are of a brilliant white, some have been found of a beautiful tint of pink, of the colour of gold, and a few entirely black. These variations are, however, very uncommon.

The pearls are discovered near the angles of the shell, and close to the hinge, where the animal is most thick and fleshy; they are generally numerous, and in some instances 150 have been taken from one oyster; on the other hand, an hundred oysters have been opened whence a pearl could not be extracted fit for any purpose whatever. Attempts were made some years past to transplant this species of oysters, but without success, as they invariably died during their transportation.

The first step previously to a fishery is the examination of the banks, which takes place at the end of October, during the short interval of fine weather usual between the close of the south-west monsoon and the commencement of the north-east. One pilot, two divers, and eight or more sailors, to each boat, are employed upon this service, and there are generally nine boats. The superintendant on the part of government accompanies the principal arripanaar, or pilot, who is taught his profession from his infancy, inheriting it from his father, in the manner of most occupations in the East. The boats visit the banks in a body, and the divers frequently descending, ascertain its exact position, and at the same time bring up a thousand or more oysters as specimens, which are examined by per-

sons who, from experience, are enabled to judge whether it is probable they are of an age calculated to answer the purposes of the intended fishing: the examination is not, however, deemed sufficient, and the oysters are opened, when the pearls are extracted, and after sorting them they are valued. It is really shocking to humanity to reflect, that if one thousand oysters produce as many pearls as are worth three pounds sterling, the fishery is undertaken, as it has been found that the examination of that number is a sufficient designation of success, or the reverse.

In the progress of this preliminary part of the undertaking, the oysters are found at various periods of their growth: those not more than one year old are very small, being less than an inch in circumference, and the full grown oysters are as large as the palm of the hand of a man: between the ages of four and five years the seed pearl only is discovered; but after this period they increase in size very rapidly; and, as has been before observed, they die after the eighth year. After completely satisfying themselves as to the probability of future success, the result is published, for the information of those who may be inclined to partake of the probable advantages. Since the island of Ceylon has been a part of the British empire, each fishing season has either been reserved for the exclusive use of government, or rented to speculative persons: but the produce has never amounted to 200,000*l.* on any one occasion. The most common practice is to farm the season to an individual, who lets the right of partaking to others.

The fourteen banks, or beds, on which the oysters are found, are situated in the bottom of the gulph of Manaar, and are included in a space about thirty miles in length, from north to south, and twenty-four in breadth. It has been ascertained, that the largest of those beds is ten miles long, and two broad; the remainder are much smaller; nor are they all equally productive, as it seldom happens that more than three beds can be marked for use in any given season. The spots where the oysters lay are not raised higher than the surrounding parts, except by their accumulation, and the coral rocks, on which the most valuable are placed, are on a level with the sand: the depth of water over them varies from eighteen to ninety feet, and the most convenient and best fishing is at the depth of between six and eight fathoms. When it is thought proper to undertake a fishery, advertisements are issued in the English and Malabar languages, inviting the possessors of boats suited for the purpose, and all divers, to meet on the 20th of February, in the bay of Condaatchy: vessels of this description assemble from various places on the coast of Coromandel, completely equipped, and furnished with every necessary for the accomplishment of their intentions: those are open, of about one ton burthen, forty-five feet in length, seven or eight wide, and three deep in the hold; and are so constructed as to draw not more than eight or ten inches water, unless they are heavily laden, and are navigated with one sail only. They have a complement of twenty-three men, whose employments are thus appropriated: one pilot; one man for the helm; another to take care of the boat; one to lade out water; ten divers; ten mundrees, who haul up the divers, the stones, and the baskets; and a peon attends on the part of the renter to take care that his interests do not suffer from fraud.

A second examination of the banks takes place a few days before the operations begin, which is merely for the purpose of anchoring buoys, to point out the situation of the banks, and those parts of them most abounding with the object of search. A small sloop is from the first stationed in the centre of the banks, where she remains, for the double purpose of guarding the buoys, and as a guide to the boats. The pilot boats make a circuit of twelve or fifteen miles round the sloop, sounding and sending down the divers, and upon discovering a place remarkable for the number of oysters, a buoy is immediately placed over it, which consists of triangular rafts of wood, fastened by a cable attached to a wooden anchor, sunk by two stones. The rafts support flags of various colours; and drawings of those are inserted in a book, where a minute description is given of the name, quality, and age of the oysters on the bank under each flag. Three hours sailing of the boats employed in the pearl fishery from the shore of Condaatchy, or a distance of about fifteen miles, occurs between the banks and that place: unfortunately the land near them is so low, that it is impossible to make use of it in ascertaining their position; it becomes, therefore, absolutely necessary to renew at each fishery the fatiguing operation of sounding and diving, the buoys being all removed at the close of

their labours, as they would serve to point out the places for depredators to dive with success.

Mr. Cordiner, from whose late excellent account of Ceylon we have extracted most of the preceding particulars, says, "As the boats arrive at Condaatchy to be employed in the fishery, they are regularly numbered, and their description and the names of their crew are registered in a book. The fishery for the season of 1804 was let by government to a native of Jaffnapatam, who had resided for some years previously to it on the coast of Coromandel. For thirty days fishing, with 150 boats, he came under an obligation to pay 300,000 Porto Novo pagodas, or 120,000*l.* sterling. He sold the right of fishing to some of the best equipped boats for 3000 pagodas each, and that of others for 2500; but kept by far the greater part of them to fish on his own account."

After every arrangement is completed, and the boats are ready to put to sea, their navigators and the divers are roused from their slumbers by the discharge of a cannon, the sounding of horns, and the beating of a kind of drum, called by the natives *tom toms*: this signal is generally made rather before midnight, when a breeze from the land prevails; the confusion that immediately follows the movements of upwards of six thousand persons in the dark may be better conceived than described; but in defiance of every obstacle, these silly people will not depart till they have performed certain ablutions and incantations, calculated, as they suppose, to forward their views. When they have reached the banks they cast anchor, and wait the approach of day; which no sooner arrives than each boat takes its station: at six or seven o'clock the diving commences. To facilitate this operation, a species of open scaffolding is projected from each side of the vessel, and it is from the scaffold the tackle is suspended, three stones on one side and two on the other. The author we have just mentioned gives so clear and comprehensive an account of this dangerous business, which he saw performed, that we shall give part of it in his own words. "The diving stone hangs from an oar by a light country rope, and slip knot, and descends about five feet into the water. It is a stone of 56*lb.* weight, of the shape of a sugar loaf. The rope passes through a hole in the top of a stone, above which a strong loop is formed, resembling a stirrup-iron, to receive the foot of the diver," who is entirely naked, except a piece of enhio wrapped round his waist; swimming near the side of the vessel, he takes the rope in one hand, and places his foot in the stirrup on the stone; a basket is then thrown into the water to him, made of a hoop and net-work below it, in which he places the other foot: after preparing his lungs for ceasing to breathe, he presses his nostrils firmly with one hand, and with the other pulls the rope forming the slip-knot; the stone carries him instantly to the bottom, where he no sooner arrives, than he disengages himself from the stirrup, which, with the stone, is immediately drawn up by the people in the boat. The diver throws himself forward upon his face, and grasps every thing in his way as rapidly as possible, and putting it into the basket, gives a signal when it is full by pulling the rope, when that also is hauled up; he then ascends by the rope, and frequently arrives at the surface before the basket: such is the consequence of custom, that though the diver cannot descend again without an interval of rest, he seldom enters the boat, remaining swimming and floating about during the whole day.

Besides the other dangers peculiar to this pursuit, the divers are liable to be devoured by sharks; but whatever may be the cause, an accident seldom occurs, which these superstitious people attribute to the powerful aid of shark charmers, without whom, and the exercise of their diabolical incantations, they will on no account undertake their labours. The most experienced diver has never been known to remain longer than one minute and a half under water, in which time he may gather 150 oysters, if they are numerous; but he sometimes gains not more than from five to a dozen, accompanied by coral pieces of rock and other substances, for he has no time to separate and examine what he seizes. When 300 boats are employed in the fishery, it is supposed that at least 1500 divers are constantly descending, the noise of which resembles the incessant roaring of a cataract. The return of the fleet in regular order, at one or two P. M. and their arrival, with the crowds waiting to welcome their return, presents a very animating and gratifying spectacle.

The method adopted to extract the pearls is dreadfully disgusting and unwholesome, as they do not undertake this operation till the oysters have been deposited in heaps for ten days, or till the

flesh has become decidedly putrid: the reason for so doing is obvious, as the particles of decayed matter and maggots are readily floated off by repeated washings in inclined receptacles, so contrived as to arrest the progress of even the smallest pearls, as they descend by their weight. Every possible precaution is taken, by the picking and sifting, to secure the whole of the produce, and yet it is said that vast numbers are lost.

After the most valuable are selected, they are sent to be drilled; a most ingenious and delicate operation, which is thus performed: a piece of wood in the shape of an inverted cone is placed upon three legs, raising it about one foot from the ground: holes of various dimensions are made in the surface to receive the pearls: the person who drills sits close to the machine: he then drives the pearls steady into their sockets. "A well-tempered needle is fixed in a reed five inches long, with an iron point at the other end, formed to play in the socket of a cocoa nut-shell, which presses on the forehead of the driller. A bow is formed of a piece of bamboo and a string. The workman brings his right knee in a line with the machine, and places on it a small cup, formed of part of a cocoa nut-shell, which is filled with water to moderate the heat of friction. He bends his head over the machine, and applying the point of the needle to a pearl sunk in one of the pits, drills with great facility, every now and then dexterously dipping the little finger of his right hand in the water, and applying it to the middle, without impeding the operation. In this manner he bores a pearl in the space of two or three minutes, and in the course of a day perforates 300 small, or 600 large pearls."

There are different methods of fishing for pearls practised in other parts of the world; but as the Ceylon fishery eclipses them all, and the simplicity of the invention is so obvious, it would be well if it were universally adopted.

Pearl-*spar*, is a fossil of the calcareous kind, being composed of carbonate of lime, with the oxides of iron and manganese: it has received different names, and occurs massive, disseminated, and crystalized: its colours are white, often with shades of grey, yellow, or red; but by mere exposure to the air its colour darkens, it becomes brown, and at length nearly black. Specific gravity about 2.8. It does not melt before the blow-pipe, but blackens: it effervesces with acids: it is said by Bergman to consist of

Carbonate of lime	50
Oxide of iron	22
Oxide of manganese	28
	100

PEARLSTEIN, or Pearlstone, in mineralogy, occurs in round and longish vesicles. Its lustre is shining and pearly, and its colour varies from the pearl to the flesh-red and greyish black. It is composed of thin, concentric, lamellar concretions. It is translucent on the edges, easily frangible, and soft. It occurs in porphyry, and contains balls of obsidian, and is found in Hungary. It is composed of

Silex	75.25
Alumina	12.
Oxide of iron	1.6
Potash	4.5
Lime	2.5
Water	2.5
	98.35
Loss	1.65
	100

PEAT, or, as it is sometimes called, Turf, is a congeries of vegetable matter, in which the remains of organization are more or less visible; consisting of the trunks of trees, of leaves, fruits, and stringy fibres, the remains of aquatic mosses. It occurs in extensive beds, called peat mosses, occupying the surface of the soil, or covered to the depth of a few feet with sand, gravel, and other matters. It is met with in great abundance in the northern, and in some of the central districts of Europe; in moist, uncultivated, mountainous tracts, and likewise in low vallies and fenny plains; and in several parts of the western shore of Great Britain. The depth of peat mosses is very various, from a few feet to twelve or fifteen yards: its consistence is very various: sometimes in a semi-fluid state, forming a black, impassable wilderness, studded here and there by tufts of rushes: when more solid, it is scantily covered over with heath and coarse grasses: in this state it is passable by sheep and other animals, especially during the dry season of the year. In deep peat mosses the upper part is loose, and less inflammable than the lower part of the bed. When of a good quality, it is moderately com-

pact, and may be readily cut in small masses of the size of bricks. By exposure to the air it dries, and becomes very inflammable. In this country it is the common fuel of large districts of Wales and Scotland, and of some parts of England, where coal is scarce and dear. Its ashes are in high estimation as a manure, being applied in the form of a top-dressing.

PECK, a measure of capacity, four of which make a bushel.

PECORA, in natural history, the fifth order of the class Mammalia. They have no fore-teeth in the upper jaw, but several in the lower; feet hoofed, cloven: they live on herbs, chew the cud, and have four stomachs; *viz.* the paunch, to macerate and ruminate the food; the bonnet, reticulate, to receive it; the omasus, of numerous folds, to digest it; and the obomasus, to give it ascendency, and prevent putrefaction. There are eight genera, *viz.*

Antelope	Capra
Bos	Cervus
Camelus	Moschus
Camelopardalis	Ovis.

PECTIS, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Oppositifoliæ. Corymbiferæ, Jussieu. Essential character: calyx five-leaved, cylindric; florets in the ray five; down awned; receptacle naked. There are four species. These are annual plants, and natives of the West Indies.

PECULIAR, signifies a particular parish or church that hath jurisdiction within itself, for probate of wills, &c. exempt from the ordinary, and the bishop's court. The Court of Peculiars is that which deals in certain parishes, lying in several dioceses; which parishes are exempt from the jurisdiction of the bishops of those dioceses, and are peculiarly belonging to the Archbishop of Canterbury, within whose province there are fifty-seven such peculiars.

PEDALIUM, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Luridæ. Bignoniæ, Jussieu. Essential character: calyx five parted; corolla subringent, with a five-cleft border; nut suberous, four-cornered, thorny at the corners, two-celled; seeds two. There is but one species, *viz.* P. murex, prickly-fruited peladium: it is a native of the East-Indies.

PEDALS, the largest pipes of an organ, so called because played and stopped with the foot. The pedals are made square, and of wood; they are usually thirteen in number. They are of modern invention, and serve to carry the sounds an octave deeper than the rest. See ORGAN.

PEDESTAL, in architecture, the lowest part of an order of columns, being that which sustains the column, and serves it as a foot or stand. The pedestal consists of three principal parts, *viz.* a square trunk, or dye, which makes the body: a cornice, the head: and a base, the foot of the pedestal. There are as many kinds of pedestals as there are of orders of columns, *viz.* the Tuscan, Doric, Ionic, Corinthian, and Composite. See ARCHITECTURE.

PEDESTALS *of statues*, are such as serve to support statues or figures. Vignola observes, that there is no part of architecture more arbitrary, and in which more liberty may be taken, than in the pedestals of statues; there being no rules of laws prescribed by antiquity, nor any settled even by the moderns. There being then no fixed proportion for these pedestals, the height depends on the situation, and the figure that they sustain: when on the ground, the pedestal is usually two-thirds or two-fifths of that of the statue; the more massive the statue is, the stronger the pedestal must be. Their form and character, &c. are to be extraordinary and ingenious, far from the regularity and simplicity of the pedestals of columns. The same author gives a multiplicity of forms, as oval, triangular, multangular, &c.

PEDICELLARIA, in natural history, a genus of the Vermes Mollusca class and order. Body soft, and seated on a rigid, fixed peduncle; aperture single. Three species only are enumerated. P. globifera; head spherical; inhabits the Northern seas, among the spines of echini; body minute, and resembling a mucor; head reddish, having the appearance of a small cherry; peduncle or stem tawny, and covered with a gelatinous hyaline skin. P. tridens: head three-lobed, the lobes oval and awned; neck round: this class inhabits the Northern Seas, among the spines of the echini: the neck is smooth and hyaline, sometimes reddish; lobes of the head sometimes four, and three times as long as the neck, rarely unarmed with awn; peduncle reddish, and three times as long as the neck.

PEDICELLUS, in botany, a partial flower stalk, or the proper stalk of any single flower, in an aggregate or head of flowers. The principal stalk, which supports all the flowers, is called the common flower stalk: the stalk of each par-

tial flower, if it has one, is styled the proper flower-stalk, or "pedicellus."

PEDICULARIS, in botany, *louse-wort*, or *red-rattle*, a genus of the Didynamia Angiospermia class and order Natural order of Personatæ. Pediculares, Jussieu. Essential character: calyx five-cleft; capsule two-celled, mucronate, oblique; seeds coated. There are nineteen species.

PEDICULUS, in botany, a foot-stalk, so called by former botanists; but Linnæus has substituted, in its stead, "petrolus," for the foot-stalk of the leaves; and "pedunculus," for the foot-stalk of the flowers.

PEDICULUS, in natural history, the *louse*, a genus of insects, of the order Aptera. Generic character: mouth with a retractile, recurved sucker, without proboscis; no feelers; antennæ as long as the thorax; two eyes; abdomen depressed; legs six, formed for running. These live by extracting animal juices; the larvæ and pupæ are six-footed, and nimble, resembling the perfect insect. There are between seventy and eighty species: of these some infest the bodies of quadrupeds, others of birds, and some even of insects themselves. P. humanus, or common louse, is distinguished by its pale, livid colour, and lobated, oval abdomen. It is produced from a small oval egg, popularly called by the name of a nit, which is fastened or agglutinated by its smaller end to the hair on which it is deposited: from this egg proceeds the insect, complete in all its parts, and only different from the parent animal in its smaller size. When examined by the microscope, it is seen that the trunk, or proboscis, which is generally concealed in its sheath or tube, is of a very sharp form, and is furnished towards the upper part with a few reversed aculei or prickles; the eyes are large, smooth, and black; the stomach and intestines afford a very distinct view of the peristaltic motion; the legs are each terminated by a double claw, not very much unlike that of a lobster, but of a sharper form; and the whole animal is every where covered by a strong granulated skin. Few insects are more prolific than the louse. It is said, that in about eight weeks a louse might see five thousand of its own descendants.

Each species of animal has a species of louse peculiar to itself, and sometimes more than one species, but the same is not to be found on two distinct animals. It is a fact well worthy of remark, that the louse of the negro is specifically distinct from that of the white man.

PEDIMENT, in architecture, is a kind of low pinnacle, serving to crown an ordonnance, or finish a frontispiece, and is placed as an ornament over gates, doors, windows, niches, altars, &c. being ordinarily of a triangular form, but sometimes forming an arch of a circle.

PEDOMETER. See PERAMBULATOR.

PEDUNCULUS, in botany, the foot-stalk of a flower, or head of flowers: the pedunculus elevates the flower and fruit only, without the leaves; the petiolus, or leaf-stalk, supports the leaves only, without the flower or fruit. Flower-stalks have different epithets, from the place which they occupy on the plant. When they proceed from the root, they are termed radicles; when from the stem, trunk-stalks; and when from the branch, branch-stalks. They sometimes afford excellent characters in discriminating the species: an example is found in a species of the globe amaranth, which is distinguished by its flower-stalks being furnished with two leaves that are placed opposite, and immediately under each head of flowers.

PEEK, in sea-language, is a word used in various senses: thus, the anchor is said to be a-peek, when the ship, being about to weigh, comes over her anchor in such a manner, that the cable hangs perpendicularly betwixt the hawse and the anchor. To heave a-peek, is to bring the peek so as that the anchor may hang a-peek. A ship is said to ride a-peek, when, lying with her main and fore yards hoisted up, one end of her yards is brought down to the shrouds, and the other raised up an end, which is chiefly done when she lies in rivers, lest other ships falling foul of the yards should break them. Riding a-broad peak, denotes much the same, excepting that the yards are only raised to half the height.

PEER, in general, signifies an equal, or one of the same rank and station: hence, in the acts of some councils, we find these words, with the consent of our peers, bishops, abbots, &c. Afterwards the same term was applied to the vassals or tenants of the same lord, who were called peers, because they were all equal in condition, and obliged to serve and attend him in his courts; and peers in fiefs, because they all held fiefs of the same lord. The term peers is now applied to those who are impannelled in an inquest upon a person, for convicting or acquitting him of

any offence laid to his charge; and the reason why the jury is so called, is, because by the common law, and the custom of this kingdom, every person is to be tried by his peers, or equals, a lord by the lords, and a commoner by commoners. See JURY.

PEER *of the realm*, a noble lord who has a seat and vote in the House of Lords, which is also called the House of Peers. These lords are called peers, because, though there is a distinction of degrees in our nobility, yet in public actions they are equal, as in their votes in Parliament, and in trying any nobleman, or other person impeached by the Commons, &c. See PARLIAMENT.

All the peers who have a right to sit and vote in Parliament, are to be summoned at least twenty days before the trial of a peer indicted for treason or felony: the method of proceeding in which is, after the indictment is found, the King, by commission under the great seal, appoints one of the peers, and generally the Lord Chancellor, to be Lord High Steward, who in these cases sits as judge. In order to bring the indictment before him, a certiorari is issued out of the Court of Chancery; and another writ also issues for bringing up the prisoner, a precept being made for that purpose by the Lord High Steward, assigning a day, and the place of trial, and for summoning the peers, twelve of whom are at least to be present, and as many more as choose to be present. The day of trial being come, and the Lord High Steward being seated in his usual state, after the commission is read, and the particular ceremonies are over, his lordship declares to the prisoner at the bar the cause of their assembly, assures him of justice, and at the same time encourages him to answer without fear; on which the indictment is read over, and the prisoner arraigned; when, after hearing all the evidence produced for the King, and the prisoner's answer, the prisoner is ordered to withdraw from the bar, when the lords go to some place by themselves, to consider of the evidence; and afterwards, being returned in order to give their verdict, the Lord High Steward openly demands of the lords, one by one, beginning with the puisne lord, whether the prisoner, calling him by his name, be guilty of the crime for which he is arraigned; when, laying their right hand upon their left breast, they separately answer, either guilty, or not guilty, upon their honour; and if he be found guilty by a majority of votes more than twelve, he is brought to the bar again, when the Lord High Steward acquaints the prisoner with the verdict of his peers, and passes sentence and judgment accordingly. It has been adjudged, that where such trial is by commission, as above, the Lord High Steward, after a verdict given, may take time to advise upon it, and his office continues till he passes judgment.

A peer is not to be put upon any inquest, even though the cause has a relation to two peers; but in trials where any peer is either plaintiff or defendant, there must be two or more knights returned on the jury. Where a peer is defendant in a court of equity, he is not to be sworn to his answer, but it may be upon his honour, as in the trial of peers: however, when a peer is to answer to interrogatories, or to make an affidavit, or is to be examined as a witness, he is to be sworn.

PEERESS, a woman who is noble by descent, creation or marriage. If a peeress by descent or creation, marries a person under the degree of nobility, she still continues noble; but if she obtains that dignity only by marriage, she loses it on her afterwards marrying a commoner; yet, by the courtesy of England, she always retains the title of her nobility. No peeress can be arrested for debt or trespass; for though, on account of their sex, peeresses cannot sit in the House of Lords, yet they enjoy the privileges of peers, and therefore all peeresses by birth are to be tried by their peers.

PEGANUM, in botany, a genus of the Dodecandria Monogynia class and order. Natural order of Multisiliquæ. Rutaceæ, Jussieu. Essential character; calyx five-leaved, or none; corolla five petalled; capsule three-celled, three-valved, many-seeded. There are two species, *viz.* P. harmala, a native of Spain, and P. dauricum, a native of Siberia.

PEGASUS, in astronomy, a constellation of the northern hemisphere, in form of a flying horse.

PEGASUS, in natural history, a genus of fishes of the order Cartilaginei. Generic character: snout elongated; mouth beneath; pectoral fins large; ventral fins single-rayed; body compressed downwards, mailed; abdomen divided with bony segments. There are three species. P. draco is found in the seas of India, and is about three inches long, and distinguished by having its pectoral fins of so extraordinary a size, that it is enabled

by them to maintain a short flight on the surface of the water: in this respect resembling the exocœti, and several other fishes. The two other species are also found in the Indian Seas.

PELARGONIUM, in botany, *crane's bill*, a genus of the Monadelphia Heptandria class and order. Natural order of Gruinales. Gerania, Jussieu. Essential character: calyx five-parted, the upper segment ending in a capillary, nectariferous tube, running along the peduncle; corolla five-petalled, irregular; filaments ten, unequal, three of which are castrated; fruit five-grained, beaked; beak spiral, bearded within. There are eighty-two species: almost all of them are natives of Africa, particularly those which are shrubby come from the Cape of Good Hope.

PELECANUS, the *pelican*, in natural history, a genus of birds of the order Anseres. Generic character: bill straight, hooked at the point; nostrils in an almost obliterated furrow; face almost naked of feathers; gullet naked, and capable of great distention; four toes, all webbed together. There are thirty species, of which we shall notice the following:

P. onocrotalus, or the great pelican, is sometimes of the weight of twenty-five pounds, and of the width, between the extreme points of the wings, of fifteen feet; the skin, between the sides of the upper mandible, is extremely dilatable, reaching more than half a foot down the neck, and capable of containing many quarts of water. This skin is often used by sailors for tobacco-pouches, and has been occasionally converted into elegant ladies' work-bags. About the Caspian and Black Seas, these birds are very numerous and they are chiefly to be found in the warmer regions, inhabiting almost every country of Africa. They build in the small isles of lakes, far from the habitations of man. The nest is a foot and a half in diameter, and the female if molested will remove her eggs into the water till the cause of annoyance is removed, returning them then to her nest of reeds and grass. These birds, though living principally upon fishes, often build in the midst of desarts, where that element is rarely to be found. They are extremely dexterous in diving for their prey, and after having filled their pouch, will retire to some rock, and swallow what they have taken at their leisure. They are said to unite with other birds in the pursuit of fishes. The pelicans dive, and drive the fish into the shallows. The cormorants assist, by flapping their wings on the surface, and forming a crescent, perpetually contracting, they at length accomplish their object, and compel vast numbers into creeks and shallows, where they gratify their voracity with perfect ease, and to the most astonishing excess.

P. occidentalis, or the American pelican, is about the size of a goose: of this bird it is reported, that it will bring supplies of food to any disabled and diseased companion; and that the natives of the island of Assumption, by confining one near the shore, frequently induce others to make these generous presents, which are fradulently converted to the purpose of food for the islanders.

The red-backed pelican. One of these was in the possession of Mr. Latham, and was found, on an experiment purposely made, to store away ten fishes, weighing a pound each, in its pouch, arranging them with the head towards the throat. It then marched away to swallow them at its leisure; the pouch being extended nearly down to its feet.

P. aquilus, or the man of war bird, is small in body, but between the extremities of the wings fourteen feet in width. It is seldom seen but within the tropics, and not unfrequently is observed two hundred leagues from land. It watches the movements of fishes from a very considerable height, and pounces upon them with unfailing success, returning from its immersion with equal rapidity. It also often obliges other birds to quit the prey which they have just made, and are flying off with, and seizes it as it drops from them with a dexterity truly admirable. During the movements of flying fishes over the surface of the sea, which are previously indicated to this bird by the bubbling of the water, it is one of their most vigilant and fatal enemies.

P. carbo, or cormorant, is nearly as large as a goose, is found in many places both of the old and the new world, and is to be met with very common on the sea coast and harbours of the United States, known in many parts by the name of "Negro-Geese." They swim with the body under water, the neck and head only erect and above the surface; at the flash of a gun or the approach of any danger they dive instantaneously, remain a considerable time under water, and rise at a distance. They have a very offensive smell, and the flesh is not palateable. These birds are shy and craf-

ty, but frequently eat to so great an excess as to induce a species of lethargy, in which, in England, they are caught by nets thrown over them without their making an effort to escape. They are trained by the Chinese to fish for them. By a ring placed round their necks, they are prevented from swallowing what they take, and, when their pouches are filled, they unload them, and, at the command of their owners, renew their divings: two will be seen combining their efforts to secure a fish, too large for the management of one only. When their work is finished to the employer's satisfaction, the birds have a full allotment of the spoil, for their reward and encouragement. In Macao, also, these birds are thus domesticated, taking extreme delight in the exercise, and constituting a source of very considerable profit to their owners. They were formerly trained, and used in the same manner in England; and Charles I. had an officer of his household, called master of the cormorants. See Aves, Plate XI. fig. 3.

P. bassanus, or the island-goose, or gannet, weighs about seven pounds, and inhabits, in great numbers, the northern isles of Great Britain. It is migratory, and drawn to that country by the shoals of herrings and pilchards, whose movements it watches with the most anxious vigilance. The young birds are sold in great plenty at Edinburgh, where they are frequently introduced before dinner as a stimulus to appetite. In St. Kilda, it is supposed that upwards of twenty thousand of these birds are taken annually. They constitute an important article of food to the inhabitants, who, to procure both the eggs and the young ones, expose themselves to the most imminent dangers on elevated and precipitous cliffs, and, in several instances, have fallen victims to the hardihood with which they have pursued their researches. See Aves, Plate XI. fig. 4.

PELECOIDES, in geometry, a figure in form of an hatchet: such is the figure B C D A, Plate XII. Miscel. fig. 7. contained under the two inverted quadrantal arcs, A B, and AD, and the semi-circle B C D. The area of the pelecoides is demonstrated to be equal to the square, A C, and that again to the parallelogram, E B. It is equal to the square, A C, because it wants of the square on the left hand the two segments, A B, and A C, which are equal to the two segments, B C, and C D, by which it exceeds on the right hand.

PELICAN. See Pelecanus.

PELLETS, in heraldry, are those roundles that are black, called also ogresses and gun-stones, and by the French torteaux de sable.

PELTA, in botany, a term by which the flower or flat fructification of the genus lichen or lever-wort is characterized, which, in most of its species, is glued to the edges of the leaves.

PELTARIA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ. Cruciformes or Cruciferæ. Essential character: silicle entire, suborbiculate, compressed, flat, not opening. There are two species, *viz.* P. alliacea, garlick scented peltaria, and P. capensis, cape peltaria.

PELVIS, in anatomy, the lower part of the cavity of the abdomen, thus called from its resemblance to a basin, or ewer, in Latin called pelvis. It is formed by the ossa iliæ and ischia, the os sacrum, the os coccygis, and the ossa pubis. See Anatomy.

PEN, *fountain*, is a pen made of silver, brass, &c. contrived to contain a considerable quantity of ink, and let it flow out by gentle degrees, so as to supply the writer a long time without being under the necessity of taking fresh ink.

PENÆA, in botany, so named from Peter Pena, a genus of the Tetrandria Monogynia class and order. Essential character: calyx two-leaved; corolla bell-shaped; style quadrangular; capsule four cornered, four-celled, eight-seeded. There are nine species; these are shrubs which are rugged below, with the vestiges of fallen leaves, leafy above; leaves opposite, crosswise, sessile, approximating imbricately in a fourfold row, the upper ones near the flowers, like scales, and coloured; flowers terminating, sessile, solitary, or several together; fruit as in the order of Acanthi, but four celled; this genus may perhaps be allied to them, but having been hitherto little examined, except in dried specimens, the natural order of the genus Penæa must yet remain uncertain. Jussieu.

PENAL *Laws* or *Statutes*, having been made on many occasions, to punish and deter offenders, they ought to be construed strictly, and not be extended by equity, but the words of them may be interpreted beneficially, according to the intent of the legislator.

PENALTY, is a forfeiture inflicted for not complying with the regulations of certain acts of parliament; a penalty is

also annexed to secure the performance of certain covenants in a deed, articles of agreement, copartnership, &c. In a bond also for payment of money, it is usual to annex a penalty in double the amount of the obligation. See Bond.

PENCIL, an instrument used by painters for laying on their colours. Pencils are of various kinds, and made of various materials; the larger sorts are made of boars bristles, the thick ends of which are bound to a stick, bigger or less, according to the uses they are designed for; these, when large, are called brushes. The finer sorts of pencils are made of camels, badgers, and squirrels-hair, and of the down of swans; these are tied at the upper end with a piece of strong thread, and inclosed in the barrel of a quill. All good pencils on being drawn between the lips come to a fine point.

Pencil is also an instrument used in drawing, writing, &c. made of long pieces of black lead, or red-chalk, placed in a groove cut in a slip of cedar, on which other pieces of cedar being glued, the whole is planed round, and one of the ends being cut to a point, it is fit for use.

PENDANT, an ornament hanging at the ear, frequently consisting of diamonds, pearls, and other precious stones.

Pendants, in heraldry, parts hanging down from the label, to the number of three, four, five, or six at most, resembling the drops in the Doric frieze. When they are more than three, they must be specified in blazoning.

Pendants, of a ship, are those streamers or long colours which are split and divided into two parts ending in points, and hung at the head of masts, or at the yard-arm ends.

PENDULOUS, a term applied to any thing that bends or hangs downwards; thus, the flowers, whose slender stalks are not able to sustain their heads upright, are called pendulous flowers. See Botany and Flower.

PENDULUM, in mechanics, denotes any heavy body, so suspended as that it may vibrate or swing backwards and forwards, about some fixed point, by the force of gravity. The vibrations of a pendulum are called its oscillations. See Oscillation. A pendulum, therefore, is any body, B, (Plate XII. Miscell. fig. 8), suspended upon, and moving about, a fixed point, A, as a centre. The nature of a pendulum consists in the following particulars: 1. The times of the vibrations of a pendulum, in very small arches, are all equal. 2. The velocity of the bob, in the lowest point, will be nearly as the length of the chord of the arch which it describes in the descent. 3. The times of vibration in different pendulums, A B, A C, are as the square roots of the times of their vibrations. 4. The time of one vibration is to the time of the descent, through half the length of the pendulum, as the circumference of a circle to its diameter. 5. Whence the length of a pendulum, vibrating seconds, will be found 39.2 inches nearly; and that of an half second pendulum 9.8 inches. 6. An uniform homogeneous body B G (fig. 9) has a rod, staff, &c. which is one-third part longer than a pendulum A D, will vibrate in the same time with it.

From these properties of the pendulum we may discern its use as an universal chronometer, or regulator of time, as it is used in clocks, and such-like machines. See Chronometer, Horology, &c.

By this instrument also we can measure the distance of a ship, by measuring the interval of time between the fire and the sound of the gun; also the distance of a cloud, by numbering the seconds, or half-seconds, between the lightning and thunder. Thus, suppose between the lightning and thunder, we number 10 seconds; then, because sound passes through 1142 feet in one second, we have the distance of the cloud equal to 11420 feet. Again, the height of any room, or other object, may be measured by a pendulum vibrating from the top thereof. Thus, suppose a pendulum from the height of a room vibrates once in three seconds; then say, as 1 is to the square of 3, *viz.* 9, so is 39.2 to 352.8 feet, the height required. Lastly, by the pendulum we discover the different force of gravity on different parts of the earth's surface, and thence the true figure of the earth.

When pendulums were first applied to clocks, they were made very short; and, the arches of the circle being large, the time of vibration through different arches could not in that case be equal; to effect which, the pendulum was contrived to vibrate in the arch of a cycloid, by making it play between two semi-cycloids C B, C D (fig. 10), whereby it describes the cycloid B E A D; the property of which curve is, that a body vibrating in it will describe all its arches, great or small, in equal times. These are, however, which concur in rendering the ap-

plication of this curve to the vibration of pendulums designed for the measures of time, the source of errors even greater than those which by its peculiar property it is intended to obviate, and it is now not used.

Although the times of vibration of a pendulum in different arches be nearly equal, yet if the arches differ very considerably, the vibrations will be performed in different times, and the difference, though very small, will become sensible in the course of one day or more. In clocks for astronomical purposes, the arc of vibration must be accurately ascertained, and if it be different from that described by the pendulum, when the clock keeps time, a correction must be applied to the time shown by the clock. This correction, expressed in seconds of time, will be equal to the half of three times the difference of the square of the given arc, and of that of the arc described by the pendulum when the clock keeps time, these arcs being expressed in degrees; and so much will the clock gain or lose, according as the first of these arches is less or greater than the second. Thus, if a clock keeps true time when the pendulum vibrates in an arch of 3°, it will lose $10\frac{1}{2}$ seconds daily in an arch of 4°, and 24 seconds in an arc of 5°, for $\overline{4^2-3^2}\times\frac{3}{2}=7\times\frac{3}{2}=10\frac{1}{2}$ and generally $\overline{B^2-A^2}\times\frac{3}{2}$ gives the time lost or gained. See Simpson's Fluxions, vol. ii. prob. xxviii.

In all that has been hitherto said, the power of gravity has been supposed constantly the same. But, if the said power varies, the lengths of pendulums must vary in the same proportion, in order that they may vibrate in equal times; for we have shewn, that the ratio of the times of vibration and descent through half the lengths is given, and consequently the times of vibration and descent through the whole length is given; but the times of vibration are supposed equal, therefore the times of descent through the lengths of the pendulum are equal. But bodies descending through unequal spaces, in equal times, are impelled by powers that are as the spaces described, that is, the powers of gravity are as the lengths of the pendulums.

Pendulums' length in latitude of London, to swing

	Inches.
Seconds	39.2
½ Seconds	9.8
¼ Seconds	2.45

Length of Pendulums to vibrate Seconds at every Fifth Degree of Latitude.

Degrees of Latitude.	Length of Pendulum.	Degrees of Latitude.	Length of Pendulum.	Degrees of Latitude.	Length of Pendulum.
	Inches.		Inches.		Inches.
0	39.027	35	39.084	65	39.168
5	39.029	40	39.097	70	39.177
10	39.032	45	39.111	75	39.185
15	39.036	50	39.126	80	39.191
20	39.044	55	39.142	85	39.195
25	39.057	60	39.158	90	39.197
30	39.070				

Rule. To find the length of a pendulum to make any number of vibrations, and *vice versa*. Call the pendulum, making 60 vibrations the standard length; then say, as the square of the given number of vibrations is to the square of 60, so is the length of the standard to the length sought. If the length of the pendulum be given, and the number of vibrations it makes in a minute be required; say, as the given length is to the standard length, so is the square of 60, its vibrations in a minute, to the square of the number required. The square root of which will be the number of vibrations made in a minute.

The greatest inconvenience attending this most useful instrument is, that it is constantly liable to an alteration of its length, from the effects of heat and cold, which very sensibly expand and contract all metalline bodies. See Heat, Pyrometer, &c.

To remedy this inconvenience, the common method is by applying the bob of the pendulum with a screw; so that it may be at any time made longer or shorter, according as the bob is screwed downwards or upwards, and thereby the time of its vibrations kept always the same. Again, if a glass or metalline tube, uniform throughout, filled with quicksilver, and 58.8 inches long, were applied to a clock, it would vibrate seconds for 39.2 = $\frac{2}{3}$ of 58.8, and such a pendulum admits of a twofold expansion and contraction, *viz.* one of the metal, and the other of the mercury, and these will be at the same time contrary, and therefore will correct each other. For by what we have shewn, the metal will extend in length with heat, and so the pendulum will vibrate slower on that account. The mercury also will expand with heat, and since by this ex-

pansion it must extend the length of the column upward, and consequently raise the centre of oscillation; so that by this means its distance from the point of suspension will be shortened, and therefore the pendulum on this account will vibrate quicker; wherefore, if the circumstances of the tube and mercury are skilfully adjusted, the time of the clock might, by this means, for a long course of time, continue the same, without any sensible gain or loss. This was the invention of Mr. Graham, in the year 1721, who made a clock of this sort, and compared it with one of the best of the common sort for three years together, and found the errors of the former but about one-eighth part of the latter.

Mr. Graham also made a pendulum consisting of three bars, one of steel between two of brass, and the steel bar acted upon a lever, so as to raise the pendulum, when lengthened by heat, and to let it down, when shortened by cold; but he found this clock liable to sudden starts and jerks in its motion.

The ingenious Mr. Ellicott, in the Transactions of the Royal Society, describes a pendulum of his invention, composed of brass and iron, with the method of applying it, so as to avoid the many jerks to which the machine might be liable.

But besides the irregularities arising from heat and cold, pendulum clocks are liable to others from friction and foulness; to obviate which, Mr. Harrison has several excellent contrivances, whereby his clocks are almost entirely free from friction, and never need to be cleaned. See Longitude.

The gridiron pendulum is a contrivance for the same purpose. Instead of one rod, this pendulum is composed of any convenient odd number of rods, as five, seven, or nine; being so connected, that the effect of one set of them counteracts that of the other set; and therefore, if they are properly adjusted to each other, the centres of suspension and oscillation will always be equidistant. Fig. 11 represents a gridiron pendulum composed of nine rods, steel and brass alternately. The two outer rods, A B, C D, which are of steel, are fastened to the cross pieces A C, B D by means of pins. The next two rods, E F, G H, are of brass, and are fastened to the lower bar B D, and to the second upper bar E G. The two following rods are of steel, and are fastened to the cross bars EG and IK. The two rods adjacent to the central rod being of brass, are fastened to the cross pieces I K and L M; and the central rod, to which the ball of the pendulum is attached, is suspended from the cross piece L M, and passes freely through a perforation in each of the cross bars I K, B D. From this disposition of the rods, it is evident that, by the expansion of the extreme rods, the cross piece B D, and the two rods attached to it, will descend: but since these rods are expanded by the same heat, the cross piece E G will consequently be raised, and therefore also the two next rods; but because these rods are also expanded, the cross bar I K will descend: and by the expansion of the two next rods, the piece L M will be raised a quantity sufficient to counteract the expansion of the central rod. Whence it is obvious, that the effect of the steel rods is to increase the length of the pendulum in hot weather, and to diminish it in cold weather, and that the brass rods have a contrary effect upon the pendulum. The effect of the brass rods must, however, be equivalent not only to that of the steel rods, but also to the part above the frame and spring, which connects it with the cock, and to that part between the lower part of the frame and the centre of the ball.

Another excellent contrivance for the same purpose is described in a French author on clock-making. It was used in the north of England by an ingenious artist about fifty years ago. This invention is as follows: a bar of the same metal with the rod of the pendulum, and of the same dimensions, is placed against the back-part of the clock-case: from the top of this a part projects, to which the upper part of the pendulum is connected by two fine pliable chains or silken strings, which just below pass between two plates of brass, whose lower edges will always terminate the length of the pendulum at the upper end. These plates are supported on a pedestal fixed to the back of the case. The bar rests upon an immoveable base at the lower part of the case; and is inserted into a groove, by which means it is always retained in the same position. From this construction, it is evident that the extension or contraction of this bar, and of the rod of the pendulum, will be equal, and in contrary directions. For suppose the rod of the pendulum to be expanded any given quantity by heat; then, as the

lower end of the bar rests upon a fixed point, the bar will be expanded upwards, and raise the upper end of the pendulum just as much as its length was increased; and hence its length below the plates will be the same as before. Of this pendulum, somewhat improved by Mr. Crosthwaite, watch and clockmaker, Dublin, we have the following description, "A and B (fig. 12), are two rods of steel forged out of the same bar, at the same time, of the same temper, and in every respect similar. On the top of B is formed a gibbet C; this rod is firmly supported by a steel bracket D, fixed on a large piece of marble E, firmly set into the wall F, and having liberty to move freely upwards between cross staples of brass, 1, 2, 3, 4, which touch only in a point in front and rear (the staples having been carefully formed for that purpose); to the other rod is firmly fixed by its centre the lens G, of twenty-four pounds weight, although it should in strictness be a little below it. This pendulum is suspended by a short steel spring on the gibbet at C: all which is entirely independent of the clock. To the back of the clock-plate, I, are firmly screwed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining power is applied by a cylindrical steel-stud, in the usual way of regulators at M. Now, it is very evident, that any expansion or contraction that takes place in either of these exactly similar rods, is instantly counteracted by the other; whereas in all compensation pendulums composed of different materials, however just the calculation may seem to be, that can never be the case, as not only different metals, but also different bars of the same metal, that are not manufactured at the same time, and exactly in the same manner, are found by a good pyrometer to differ materially in their degrees of expansion and contraction, a very small change affecting one and not the other." The expansion or contraction of straight-grained fir-wood lengthwise, by change of temperature, is so small, that it is found to make very good pendulum rods. The wood called sapadillo is said to be still better. There is good reason to believe, that the previous baking, varnishing, gilding, or soaking of these woods in any melted matter, only tends to impair the property that renders them valuable. They should be simply rubbed on the outside with wax and a cloth. In pendulums of this construction the error is greatly diminished, but not taken away.

PENGUIN. See Aptenodytes.

PENELOPE, in natural history, a genus of birds of the order Gallina. By Latham, they are mostly arranged under the genus Meleagris, or the Turkey. Their legs, however, are without spurs. They inhabit principally South America, and particularly Brasil and Guiana. The P. cristata, or guan, is two feet six inches in length. P. cumanensis, or the yacou, is of the size of a hen turkey, and is found in Cayenne and Guiana. The Marail is found in flocks in Guiana, feeds on fruits, and roosts on trees. See Aves, Plate XI. fig. 5.

PENIS. See Anatomy.

PENNANTIA, in botany, so named in honour of Thomas Pennant, a genus of the Polygamia Dioecia class and order. Essential character: calyx, none; corolla five petalled; stamens five: pericarpium, three sided, two-celled, with solitary subtriquetrous seeds. There is but one species, *viz.* P. corymbosa, a native of New Zealand.

PENNATULA, in natural history, *sea-pen*, a genus of the Vermes Zoophyta class and order; animal not affixed, of various shapes, supported by a bony part within, naked at the base, the upper part with generally lateral ramifications, furnished with rows of tubular denticles producing radiate polypes from each tube. There are about eighteen species, of which P. coccinea is described as stem round, radiating, with papillous polype-bearing sides, and clavate at the top. It is found in the White Sea, is soft, red, an inch and a half high, and as thick as the little finger, wrinkled, with the papillæ disposed in rows. P. phosphorea has a fleshy stem, with a rough midrib, and imbricate ramification. It inhabits most seas, and emits a very strong phosphoric light in the dark; about four inches long, red, stem villous, with a lanceolate rough midrib, and nearly incumbent rays, the tubes pointing all one way. P. reniformis: stem round, vermicular, supporting a kidney-shaped leaf-like head, producing polypes on one surface. It inhabits South Carolina: body expanded, kidney-shaped, flat, rising from a short round stem, and covered on the upper surface with numerous tubular orifices, through which the polypes are obtruded at pleasure; the upper surface is of a rich purple, the underside brilliant, and sometimes yellowish.

PENNY, an ancient silver coin, which, though now little used, was the only one current among our Saxon ancestors. It was then equal to $\frac{1}{240}$th part of a pound. In Etheldred's time the penny was the 20th part of the Troy ounce, hence the denomination penny-weight. Till the time of Edward the first, the penny was struck with a cross so deeply sunk into it, that it might on occasion be easily broken, and parted into halves and quarters, hence the term half-pence, and farthings, or four things. We have now copper pence, which are much used in the way of change. They are manufactured by Mr. Bolton, and are very handsome coins.

Penny *weight*, a Troy-weight, containing twenty-four grains, each of which is equal in weight to a grain of wheat, gathered out of the middle of the ear, and well dried.

PENSION, no person having a pension from the crown, during pleasure, or for any term of years, is capable of being elected a member of the House of Commons. To receive a pension from a foreign prince or state, without leave of the king, has been held to be criminal, because it may incline a man to prefer the interest of such foreign prince to that of his own country.

PENSIONER, in general, denotes a person who receives a pension, yearly salary, or allowance. Hence,

The band of gentlemen-pensioners, the noblest sort of guard to the king's person, consists of forty gentlemen, who receive a yearly pension of one hundred pounds. This honourable band was first instituted by King Henry VIII, and their office is to attend the King's person, with their battle-axes, to and from his chapel-royal, and to receive him in the presence chamber, or coming out of his privy-lodgings; they are also to attend at all great solemnities, as coronations, St. George's feast, public audiences of embassadors, at the sovereign's going to parliament, &c.

They are each obliged to keep three double horses and a servant, and so are properly a troop of horse. They wait half at a time, quarterly; but on Christmas-day, Easter-day, Whitsunday, &c. and on extraordinary occasions, they are all obliged to give their attendance. They have likewise the honour to carry up the sovereign's dinner on the coronation-day, and St. George's feast; at which times, the King or Queen usually confer the honour of knighthood on two such gentlemen of the band as their captain presents. Their arms are gilt battle-axes; and their weapons, on horse-back, in time of war, are cuirassiers-arms, with sword and pistols. Their standard, in time of war, is, argent, a cross gules. Their captain is always a nobleman, who has under him a lieutenant, a standard-bearer, a clerk of the check, secretary, paymaster, and harbinger.

PENSTOCK, a sluice, or flood-gate, serving to retain or let go, at pleasure, the water of a mill-pond, or the like.

PENTACHORD, an ancient musical instrument, with five strings, whence the name.

PENTAGON, in geometry, a figure of five sides and five angles. If the five sides be equal, the angles are so too, and the figure called a regular pentagon.

The most considerable property of a pentagon is, that one of its sides is equal in power to the sides of a hexagon and a decagon, inscribed in the same circle; that is, the square of the side of the pentagon is equal to the sum of the squares of the sides in the other two figures. The area of a pentagon, like that of any other polygon, may be obtained by resolving it into triangles. Pappus has also demonstrated, that twelve regular pentagons contain more than twenty triangles inscribed in the same circle. The dodecahedron, which is the fourth regular solid, consists of twelve pentagons. In fortification, pentagon denotes a fort with five bastions.

PENTAGRAPH, an instrument whereby designs of any kind may be copied in what proportion you please, without being skilled in drawing. (Plate Pentagraph, fig. 1), is a plan of a pentagraph, and (fig. 2 and 3), part of the same on a larger scale.

The pentagraph is made of brass, and consists of four levers A B D E, the two longest A B, are jointed together at their ends, the other two, D E, are also jointed together at one of their ends, and to the levers A B at the others. In this manner the instrument always forms a parallelogram, a A a = e E e and a B e = a D e; f, g, and h, are three tubes upon the levers, two of which, f, g, slide along upon their respective levers, and can be fixed at any point by screws (one of these tubes is shewn separately in fig. 3), any one of these tubes is adapted to receive either a fulcrum or fixed centre, round which the whole instrument turns a blunt point or tracer, to pass over the original design,

which is to be copied; or a crayon to draw the figure, or copy of the original design; these three points must be always in one right line, and by the construction of the levers, if they are once set in a line, they will continue in it through any of its motions.

The proportion in which it will reduce any figure will be easily calculated from the same principles as the lever; that the magnitude of the figures described by either of the points, will be in the same proportion to each other, as the distances of those points from the fulcrum, thus if the point *f* be the fulcrum, and if the distance from *f* to *g* be half the distance from *f* to *h*, the size of the figure described by the point *g* will be half the size of the figure described at the same time by the point *h*. The fulcrum, as we have said before, can be changed, as also the pencil and the tracer, and any of the three can be applied to either of the tubes upon the levers, if the tracer is placed in the tube *h*, the pencil in *g*, and the fulcrum at *f*, any figure described by the tracer *h*, will be exactly copied one half the size by the pencil at *g*, and if on the contrary the pencil is placed at *h*, and the tracer at *g*, the figure drawn by the pencil will be twice the size of the original traced at *g*.

When the fulcrum is placed between the two points at *g*, the figures described by each point will be inverted with respect to each other, though the same principle applies, that the magnitude of the figures will bear the same proportion to each other, as the distances of their tracing point from the fulcrum bear to each other. This last position of the instrument is seldom used on account of the figure being inverted, except when the figures traced and copied are equal to each other, or nearly so, as the first position will not allow of that.

It will be easily seen that by the sliding motion of the tubes, *g* and *f*, the proportion between the three may be varied in any degree, and for this purpose the levers are engraved, and divisions made to set the tubes by, so as to reduce it in any proportion, and at the same time put the three points in the same right line, otherwise the figures will be strangely distorted; *n n n* is a silk thread, which the operator hooks round his fore finger, by pulling this he raises up the crayon, *g*, so that it will not mark; each joint of the instrument is formed by a short axis, *i*, (fig. 2), made fast and moving with one lever, *k*, it has pivots at its ends, working in a small cock, *l*, screwed to the upper side of the other lever: beneath each joint a small tube, *m*, is screwed, its upper end receives the lower pivot of the axis *i*, and in the lower part a small spindle, *n*, is fitted, which has a castor at the bottom to support the weight of the instrument, by the turning of the spindle, *n*, the castor will run in any direction. One of these castors is also fixed at the outer end of the levers, A and B, as well as beneath each joint. Care should be taken that the table, upon which the instrument is used, is a perfect plane, otherwise errors will arise from the tracer or crayon being sometimes thrown out of the perpendicular, and it is for the same reason that the levers are jointed with an axis, as explained before.

Fig. 4, Plate Pentagraph, is the common parallel ruler, A B are two rulers connected by two bars C D, which are of equal lengths, and the distance between the pins by which the levers C D are fixed to the rulers are the same distance from each other in both rulers; by this means it is easily seen, that the two rulers, A B, will always move parallel to each other.

Fig. 5. is another ruler differing from the other in being double; the advantage of it over fig. 4, is, that the two rulers A B can be moved parallel to each other without sliding endways, as the other does, every part of the moving ruler describing the arc of a circle.

PENTAMETER, in ancient poetry, a kind of verse consisting of five feet, or metres; whence the name. The two first feet may be either dactyls or spondees, at pleasure; the third is always a spondee, and the two last anapests: such is the following verse of Ovid.

1 2 3 4 5
Carmini | bus vi | ves tem | pus in o | mne meis.

A pentameter verse, subjoined to an hexameter, constitutes what is called elegiac.

PENTANDRIA, in botany, the name of the fifth class of plants in the Linnæan system, consisting of plants which have hermaphrodite flowers with five stamina. There are six orders in this class, founded upon the number of styles.

PENTAPETES, in botany, a genus of the Monadelphia Dodecandria class and order. Natural order of Columniferæ. Malvaceæ, Jussieu. Essential character: calyx double, outer three-leaved; inner five-parted; stamina fifteen, with five ligules, petal shaped; capsule five-celled, many-seeded. There is but one species,

viz. P. phœnicea, scarlet-flowered pentapetes, a native of the East Indies and Japan.

PENTHORUM, in botany, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Sempervivæ, Jussieu. Essential character: calyx five or ten cleft; petals none, or five: capsule five-cusped, five-celled. There is only one species, *viz.* P. sedoides, American penthorum.

PENTSTEMON, in botany, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Essential character: calyx five-leaved; corolla bilabiate, ventricose; rudiment of a fifth stamen bearded above; capsule two-celled. There are two species, *viz.* P. lævigata, smooth pentstemon, and P. pubescens, hairy pentstemon.

PENULTIMA, or *penultimate syllable*, in grammar, denotes the last syllable but one of a word; and hence the anti-penultimate syllable is the last but two, or that immediately before the penultima.

PENUMBRA, in astronomy, a partial shade observed between the perfect shadow and the full light in an eclipse. It arises from the magnitude of the sun's body; for were he only a luminous point, the shadow would be all perfect; but by reason of the diameter of the sun, it happens that a place which is not illuminated by the whole body of the sun, does yet receive rays from a part thereof. See Astronomy.

PEPLIS, in botany, *purslane*, a genus of the Hexandria Monogynia class and order. Natural order of Calycanthemæ. Salicariæ, Jussieu. Essential character: calyx bell-shaped, with a twelve-cleft mouth; petals six, inserted into the calyx; capsule two-celled. There are two species, *viz.* P. portula, water purslane, and P. tetrandria.

PEPPER, in natural history, an aromatic berry, of a hot dry quality, chiefly used in seasoning. See Piper.

We have three kinds of pepper at this time in use in the shops; the black, the white, and the long pepper.

Black pepper is the fruit of a plant of the Diandria Trigynia class, without any flower petals; the fruit itself is roundish and rugose, and disposed in clusters: it is brought from the Dutch settlements in the East Indies.

The common white pepper is factitious, being prepared from the black in the following manner: they steep this in sea water, exposed to the heat of the sun for several days, till the rind or outer bark loosens; they then take it out, and when it is half dry, rub it till the rind falls off; then they dry the white fruit, and the remains of the rind blow away like chaff. A great deal of the heat of the pepper is taken off by this process; so that the white kind is fitter for many purposes than the black. However, there is a sort of native white pepper, produced on a species of the same plant, which is much better than the factitious, and indeed little inferior to the black.

The long pepper is a dried fruit of an inch, or an inch and a half in length, and about the thickness of a large goose quill: it is of a brownish-grey colour, cylindrical in figure, and said to be produced on a plant of the same genus.

Pepper is principally used by us in food, to assist digestion; but the people in the East Indies esteem it as a stomachic, and drink a strong infusion of it in water by way of giving them an appetite: they have also a way of making a fiery spirit of fermented fresh pepper with water, which they use for the same purpose. They have also a way of preserving the common and long pepper in vinegar, and eating them afterwards at meals.

Pepper *water*, a liquor prepared in the following manner, for microscopical observations: put common black pepper, grossly powdered, into an open vessel, so as to cover the bottom of it half an inch thick, and put to it rain or river water, till it covers it an inch; shake or stir the whole well together at the first mixing, but never disturb it afterwards: let the vessel be exposed to the air uncovered; and in a few days there will be seen a pellicle or thin skin swimming on the surface of the liquor, looking of several colours.

This is a congeries of multitudes of small animals; and being examined by the microscope, will be seen all in motion: the animals, at first sight, are so small as not to be distinguishable, unless to the greatest magnifiers; but they grow daily till they arrive at their full size. Their numbers are also continually increasing, till the whole surface of the liquor is full of them, to a considerable depth. When disturbed they will sometimes all dart down to the bottom, but they soon after come up to the surface again. The skin appears soonest in warm weather, and the animals grow the quickest; but in the severest cold it will succeed, unless the water freezes.

About the quantity of a pin's head of this scum, taken up on the nib of a new pen, or the tip of a hair pencil, is to be

laid on a plate of clear glass; and if applied first to the third magnifier, then to the second, and finally to the first, will show the different animalcules it contains, of several kinds and shapes, as well as sizes.

PEPPERMINT, a species of mint. See MENTHA.

PERAMBULATOR, a machine for measuring distances upon the ground. Its external figure is shewn in figs. 1 and 2, Plate Perambulator. A B is a mahogany wheel, strongly framed and hooped with iron, that it may not wear, it turns in a handle, D E, which the operator holds in his hand, and thus wheels it along upon the ground. At F is a piece of mechanism to register the number of revolutions the wheel has made. The pivots of the wheel work into pieces of brass let into the two arms of the handle, D E; on the end of one of its pivots, a small pinion, *a*, (fig. 3) is fixed, this turns another pinion, *b*, upon a long spindle, *d*, which conveys the motion to the machinery at F (fig. 2); both pinions have eight teeth, therefore the spindle, *d*, turns in the same time as the great wheel, A B. This spindle is let into the wood work of the handle, as is shewn in the dotted line, *d*, (fig. 2), and has a square hole in its end to receive the end of a short arbor, *e*, (fig. 4), which is an enlarged plan of the wheel work; this end has an endless screw on it turning a wheel, *f*; below this wheel, on the same arbor, is a pinion turning a wheel, *h*, and lower still is another wheel (hidden by *f*), turning a pinion, *g*, on whose arbor is the small hand, *i*, shewn in the plan of the dial plate. The wheel, *h*, has a pinion on its arbor, immediately above it, turning *k*, which has a pinion above it, turning *l*, whose arbor is a tube, and put over the orb of *h*; this tube has a short hand, *m* (fig. 5), fixed on it. The long hand, *n*, is fixed to the arbor of the wheel *h*; this arbor is not made fast to the wheel, but to a circular plate, *p*, against which the wheel fits, and to which it is held by a pin put through the arbor beneath it, by this means the hands can be turned round to set them, without moving the wheel *h*; a pin is fixed in this wheel, which *a*, every revolution, lifts and lets fall a hammer, *r*, to strike the bell, *t*, and thus give notice of the hand having completed its revolution. The great wheel is half a pole in circumference, and the wheels *a b*, being equal, the endless screw turns once for every half pole the instrument is wheeled along the ground; the screw is so cut, that it turns the wheel, *f*, once in twenty-four turns of the great wheel equal twelve poles. The lower wheel on its arbor has thirty-six teeth, and turns *g*, of twelve teeth, three times as fast, or once for four poles; this is equal to one chain, and the circle of the hand, *i*, (fig. 5) which it carries, is divided into one hundred, each equal one link; the pinion on the arbor of *f* has twelve teeth, and *h*, which it turns, has forty, it will turn once for $3\frac{1}{3}$ times of *f*, or $3\frac{1}{3}$ times 12 poles $= 40$ poles $= 1$ furlong, the dial of the hand, *n*, which it carries, is divided into forty, each equal one pole, and by the pin in the plate, *p*, it strikes the bell once each revolution. The pinion of eight on the arbor of *h*, turns *k*, of sixty-four once for eight furlongs, and its pinion of six, drives *l* of seventy-two, once round for twelve of *k*, or ninety-six furlongs, equal twelve miles. The hand, *m*, fixed to its arbor, points out these distances on a circle divided into twelve for miles, and subdivided into eight for furlongs. A small scraper is fixed to the frame to prevent the wheel gathering dirt, and thus enlarging its circumference.

In wheeling a machine along a road, care should be taken to avoid all sudden holes or hills as much as possible, without deviating from the straight line.

The bell, by striking, is of great use to point out every furlong which might otherwise be passed unnoticed.

PERCA, the *perch*, in natural history, a genus of fishes of the order Thoracici. Generic character: jaws unequal; teeth sharp and incurvated; gill-covers of three lamina, scaly and serrated; dorsal fin spiny on the fore part; scales generally hard and rough. There are sixty species, of which the following is most deserving of notice.

P. fluviatilis, or the common perch of England, is generally from one to two feet long, and two pounds and a half in weight, and inhabits the clear fresh waters of almost every country in Europe, sometimes attaining the weight of ten pounds. It is gregarious, haunts those parts where the stream is gentle and profound, is extremely rapacious, catches with avidity at almost any bait, and tenacious of vitality to an extraordinary degree, surviving a journey of fifty miles, though packed up in dry straw. It is highly valued both for its firmness and flavour, and among the Romans was held in very superior estimation.

P. striatus. Pale brown or whitish, with about eight lines running parallel with each other, on the sides. This is the fish

known by the name of "Rock fish," and in some districts by that of "Basse." It is brought to our markets in great numbers during the winter, and is in high estimation as food. Doctor Mitchell is perhaps the first describer of the "Rock;" under the specific name which we have here adopted; he has subsequently thought proper to reject this appellation, and has substituted his own name, *Mitchili.* But as he gives us no reason whatever for an alteration of so much importance, we cannot concur in adopting it. We do not know of any fish belonging to the genus as it now stands, to which the same name has been applied: the P. striatus of Linn. is not a true Perca according to the late arrangements, and therefore cannot be taken into consideration in this case by any one who adopts these arrangements.

PERCEPTION, in logic, the first and most simple act of the mind, whereby it perceives or is conscious of its ideas.

In bare perception, the mind is for the most part only passive; yet impressions made on the senses cause no perception, unless they are taken notice of by the mind, as we see in those who are intently busied in the contemplation of certain objects. It ought also to be observed, that the ideas we receive by perception are often altered by the judgment, without our taking notice of it; so that we take that for the perception of our senses, which is but an idea formed by the judgment: thus a man who reads or hears, with attention, takes little notice of the characters or sounds, but of the ideas excited in him by them.

The faculty of perception seems to be that which constitutes the distinction between the animal kingdom and the inferior parts of nature. Perception is also the first step towards knowledge, and the inlet of all the materials of it; so that the fewer senses a man has, and the duller the impressions that are made by them are, the more remote he is from that knowledge which is to be found in other men.

PERCH, or PEARCH. See PERCA.

PERCH, a measure of length equal to five yards and a half. See MEASURE.

PERCUSSION, in mechanics, the impression a body makes in falling or striking upon another, or the shock of two bodies in motion. See MOTION.

Percussion is either direct or oblique; direct, when the impulse is given in a line perpendicular to the point of contact; and oblique, when it is given in a line oblique to the point of contact. The ratio which an oblique stroke bears to a perpendicular one, is as the sine of the angle of incidence to the radius. Thus, let $a\ b$ (Plate XII. Miscel. fig. 13) be the side of any body on which an oblique force falls, with the direction $d\ a$; draw $d\ c$ at right angles to $d\ b$, a perpendicular let fall from d to the body to be moved, and make $a\ d$ the radius of a circle: it is plain that the oblique force $d\ a$, by the laws of composition and resolution of motions, will be resolved into the two forces $d\ c$ and $b\ d$; of which $d\ c$, being parallel to $a\ b$, hath no energy or force to move that body; and, consequently, $d\ b$ expresses all the power of the stroke or impulse on the body to be moved: but $d\ b$ is the right sine of the angle of incidence $d\ a\ b$; wherefore the oblique force $d\ a$, to one falling perpendicularly, is as the sine of the angle of incidence to the radius.

PERDICIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: corollets bilabiate; down simple; receptacle naked. There are six species.

PERENNIAL, in botany, is applied to those plants whose roots will abide many years, whether they retain their leaves in winter or not: those which retain their leaves are called ever-greens; but such as cast their leaves are called deciduous. Some of these have annual stalks, which die to the root every autumn, and shoot up again in the spring.

PERFECT, in arithmetic. Perfect number is, that all whose aliquot parts added together, make the same number with the number whereof they are such parts. Thus six is a perfect number, being equal $1+2+3$: so also is $28=1+2+4+7+14$. Mathematicians have been at considerable pains to investigate the perfect numbers, but with no great success, the following are given as the first six perfect numbers:

6
28
496
8128
33550336
8589869056

PERGULARIA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: contorted; nectary surrounding the gentials with five sagittated cusps; corolla salver-shaped. There are five species.

PERIANTHIUM, in botany, the *flower-*

cup, properly so called, the most common species of calyx, placed immediately under the flower, which is contained in it as a cup. The flower-cup differs in point, number, figure, proportion and situation.

PERICARPIUM. See BOTANY.

PERICRANIUM, in anatomy, a thick solid coat, or membrane, covering the outside of the cranium or skull.

PERIGEE, in astronomy, that point of the sun's or moon's orbit, wherein they are at their least distance from the earth, in which sense it stands opposed to apogee.

PERIHELIUM, in astronomy, that point of a planet's or comet's orbit, wherein it is in its least distance from the sun; in which sense it stands in opposition to aphelium.

PERILLA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of Verticellatæ. Labiatæ, Jussieu. Essential character: calyx, uppermost segment very short; stamens distant; styles two, connected. There is but one species; *viz.* P. ocymoides, an annual plant, and a native of the East Indies.

PERIMETER, in geometry, the bounds or limits of any figure or body. The perimeter of surfaces or figures are lines, those of bodies are surfaces. In circular figures, instead of perimeter, we say circumference, or periphery.

PERINÆUM, or PERINEUM. See ANATOMY.

PERIOD, in astronomy, the time taken up by a star or planet in making a revolution round the sun; or the duration of its course till it return to the same point of its orbit. See ASTRONOMY. There is a wonderful harmony between the distances of the planets from the sun, and their periods round him; the great law whereof is, that the squares of the periodical times of the primary planets, are to each other as the cubes of their distances from the sun; and likewise, the squares of the periodical times of the secondaries of any planet, are to each other as the cubes of their distances from that primary. This harmony among the planets is one of the greatest confirmations of the Copernican hypothesis.

PERIOD, in chronology, denotes a revolution of a certain number of years, or a series of years, whereby, in different nations, and on different occasions, time is measured; such are the following.

PERIOD, *Calippic*, a system of seventy-six years. The calippic period comprehends 48 common years, and 28 intercalary ones, 940 lunations, and 22,759 days. See CHRONOLOGY.

PERIOD, *Dionysian*, or *Victorian* PERIOD, a system of 532 lunæ-solar and Julian years, which being elapsed, the characters of the moon fall again upon the same day and feria, and revolve in the same order, according to the opinion of the ancients. This period is otherwise called the great paschal cycle, because the Christian church first used it, to find the true time of the pascha, or easter. The sum of these years arise by multiplying together the cycles of the sun and moon. See EASTER.

PERIOD, *Hipparchus's*, a system of 304 years, both lunar and solar, which being elapsed, Hipparchus thought that the reckoning by the lunar motion would coincide again with the solar measures. This period comprehends 3760 lunar months, or 111,039 days; the sum of which arises from the multiplication of the calippic period by 4, subtracting unity from the product.

PERIOD, in grammar, denotes a small compass of discourse, containing a perfect sentence, and distinguished at the end by a point, or full stop, thus (.); and its members or divisions marked by commas, colons, &c.

PERIOD is also used for the character (.) wherewith the periods of discourse are terminated, or expressed, being commonly called a full stop or point. See PUNCTUATION.

PERIOD, in numbers, a distinction made by a point, or comma, after every sixth place or figure; and is used in numeration for the readier distinguishing and naming the several figures or places, which see under ARITHMETIC.

PERIOECI, in geography, such inhabitants of the earth as have the same latitudes, but opposite longitudes; or live under the same parallel and the same meridian, but in different semicircles of that meridian, or in opposite points of the parallel. These have the same common seasons throughout the year, and the same phenomena of the heavenly bodies; but when it is noon-day with the one it is midnight with the other, there being twelve hours between them in an east or west direction. These are found on the globe, by the hour-index, or by turning the globe half round, that is 180 degrees either way.

PERIOSTEUM, or PERIOSTIUM, in anatomy, a nervous vasculous membrane, endued with a very quick sense, immediately surrounding in every part

both the internal and external surfaces of all the bones in the body, excepting only so much of the teeth as stand above the gums, and the peculiar places on the bones in which the muscles are inserted.

PERIPATETIC *philosophy*, that system taught and established by Aristotle, and maintained by his followers, the Peripatetics, called also Aristotelians.

The philosophy of Aristotle may be divided into three distinct branches; instrumental, theoretical, and practical. Under the first head are included his doctrines concerning logic; under the second, his principles of physics, pneumatology, ontology, and mathematics; and under the third, his system of ethics and policy. Upon all these we cannot enlarge; but shall refer to his doctrine concerning the human mind and animal life

Aristotle, having undertaken to teach a new system of philosophy, was desirous of receding as far as possible from former philosophers, and particularly from Plato; and in treating upon any subject on which he had no doctrine to offer, he gave old opinions the air of novelty, by clothing them in new language. This latter method he adopted on the subject of mind. He asserted with Plato, that there are in men different faculties, which have respectively a different organ; but he designedly expressed his doctrine upon this head in obscure terms, which cannot be explained with entire perspicuity without supposing, as many writers have done, what Aristotle ought to have taught, instead of endeavouring to discover what he actually did teach. His leading tenets on this subject are these: The soul is the first principle of action in an organised body, possessing life potentially. The soul does not move itself; for whatever moves is moved by some other moving power. It is not a rare body, composed of elements; for then it would not have perception more than the elements which compose it. The soul has three faculties, the nutritive, the sensitive, and the rational; the superior comprehending the inferior potentially. The nutritive faculty is that by which life is produced and preserved. The sensitive faculty is that by which we perceive and feel; it does not perceive itself nor its organs, but some external objects through the intervention of its organs, which are adapted to produce the sensations of sight, hearing, smell, taste, and touch. The senses receive sensible species, or forms, without matter, as wax receives the impression of a seal, without receiving any part of its substance. The external senses perceive objects; but it is the common, or internal sense, which observes their difference. The internal sense perceives various objects at the same instant. Perception differs from intellect; the former being common to all animals, the latter to a few. Fancy is the perception produced in any animal, by the immediate action of the senses. It is accompanied with different feelings, according to the nature of the object by which it is produced. Memory is derived from fancy, and has its seat in the same power of the soul. It is the effect of some image impressed upon the soul by means of the senses. Where this image cannot be retained, through an excess of moisture or dryness in the temperature of the brain, memory ceases. Reminiscence is that faculty of the mind by which we search for any thing which we wish to recollect through a series of things nearly related to it, till at last we call to mind what we had forgotten. The intellect is that part of the soul by which it understands. It is of two kinds, passive and active. Passive intellect is that faculty by which the understanding receives the forms of things: it is the seat of species. Active intellect is the efficient cause of all knowledge; and is either simple, when it is employed in the near apprehension of its object; or complex, when it compounds simple conceptions, in order to produce belief and assent. The latter is either true or false, the former neither. The action of the intellect is either theoretical or practical: theoretical, when it simply considers what is true or false; and practical, when it judges whether any thing is good or evil, and hereby excites the will to pursue or avoid it. The principle of local motion is the desire, or aversion, which arises from the practical exercise of the understanding. This desire, or aversion, produces either rational volition or sensitive appetite. The production of animal life arises from the union of the nutritive soul with animal heat. Life is the continuance of this union; death, its dissolution.

The nature of the first principle of animal life, and of all perception, intelligence, and action, Aristotle, as well as all other philosophers, was at a loss to explain. Having no other way of judging concerning it than by observing its operations as far as they are subjects of experience, he could only define the mind to be that principle by which we live, perceive, and understand. When he at-

tempted to form an abstract conception of this principle, he saw that there must be some substance which enjoys such perfection as to be capable of performing this function; but he was wholly ignorant of the nature of this substance, and therefore in defining it he made use of a term expressive of the confused idea which he had formed to himself from observing its operations, and called it perfect energy; that is, if he had confessed the truth, some substance which is adapted to produce sensitive and rational life in certain organized bodies.

This term will afford the attentive reader a striking example of the manner in which Aristotle endeavoured to explain the principles of nature by vague notions and unmeaning words. But on other subjects he is sometimes remarkably clear, as in his discussion on "Politics" he states, in few words, the only legitimate purpose of political establishments. "Every political society forms, it is plain, a sort of community or partnership, instituted for the benefit of the partners. Utility is the end and aim of every such institution; and the greatest and most extensive utility is the aim of that great association comprehending all the rest, and known by the name of the commonwealth." Having stated and explained the grand purposes of society, he considers the best systems of means for attaining those purposes, and traces the distinction of ranks which arises from the inequalities of individual talents, virtue, and fortune. Political institutions are best fitted for promoting human happiness, when they are most suitable to the opinions and sentiments of the people, and the circumstances of the times and country. No one political system will equally suit all situations, and scarcely any two. Government being an arrangement, the best government must be the best arrangement, and the best arrangement is that in which the materials to be arranged are the best fitted both to receive and to preserve. The materials of the statesman or legislator are the number and character of his people, and the extent and quality of his country. The excellence of a commonwealth, however, is not to be estimated by its populousness or extent, but by its fitness for performing its proper functions: the same energies and habits constitute the happiness both of individuals and of nations. Men make governments, not governments them; nor by any system of political arrangements can a happy commonwealth be constituted from fools or cowards, profligates or knaves. The bricks must be first prepared before the edifice can be reared. The human character is a compound of good and evil; the former arises from the balance of the affections, under the controul and guidance of reason, the latter results from passion operating without restraint. That government is the best which most powerfully stimulates the energies of the people to beneficial purposes, and restrains them from hurtful pursuits. That must be a system of freedom, in the first place tempered by order, and moderation in the second. Mixed governments, wisely formed and balanced, best correspond to the state of mankind. Democracy, though apparently most agreeable to the rights of man, is not the best adapted to his wants; the general will, unrestrained, is apt to run into excess; to be precipitate in deliberation, and tardy in execution. While simple democracy is inexpedient for the people themselves, simple aristocracy and simple monarchy are equally inexpedient; and being the subjection of the many to a few, or to one, are moreover unjust. For these reasons Aristotle recommends a constitution that combines and balances the three orders, as the most generally likely to promote the good of society.

To his "Treatise on Politics" Aristotle has added two books on "Oeconomics," in which he has treated in a similar way on the management of domestic concerns.

Nothing is to be met with in the writings of Aristotle, which decisively determines whether he thought the soul of man mortal or immortal; but the former appears most probable, from his notion of the nature and origin of the human soul, which he conceived to be an intellectual power, externally transmitted into the human body from an Eternal Intelligence, the common source of rationality to human beings. Aristotle does not inform his readers what he conceived this universal principle to be; but there is no proof that he supposed the union of this principle with any individual to continue after death.

PERIPHERY, in geometry, the circumference of a circle, ellipsis, or any other regular curvilinear figure.

PERIPLOCA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Contortæ. Apocineæ, Jussieu. Essential character: nectary encircling the gentials, and putting forth

five threads. There are thirteen species, of which P. græca, common Virginian silk, or periploca, has shrubby twining stems, covered with a dark-coloured bark, sending out slender branches, twining round each other; leaves ovate, lanceolate, nearly four inches long, and two broad in the middle; of a lucid green on their upper side, paler underneath, opposite, on short foot-stalks; the flowers appear near the ends of the small branches in bunches of a purple colour, in the months of July and August.

PERIPTERAL, in architecture, surrounded on all sides with columns, equidistant from the walls of a building.

PERISCH, in geography, the inhabitants of either frigid zone, between the polar circles and the poles; where the sun, when in the summer signs, moves only round about them, without setting, and consequently their shadows, in the same day, turn to all the points of the horizon.

PERISTALTIC, in medicine, a vermicular spontaneous motion of the intestines, performed by the contraction of the circular and longitudinal fibres, of which the fleshy coats of the intestines are composed; by means whereof the chyle is driven into the orifices of the lacteal veins, and the fæces are protruded towards the anus.

PERITROCHIUM, in mechanics, denotes a wheel, or circle, concentric with the base of a cylinder, and moveable together with it about an axis. See MECHANICS.

PERIWINKLE. See BUCCINUM.

PERMIT, a licence or warrant for persons to pass with or sell goods, having paid the duties of customs and excise.

PERMUTATION *of quantities*, in algebra, the same with combination. See COMBINATION.

PERORATION, in rhetoric, the epilogue, or last part of an oration, wherein what the orator had insisted on through his whole discourse, is urged afresh with greater vehemence and passion. The peroration consits of two parts: 1. Recapitulation, wherein the substance of what was diffused throughout the whole speech is collected briefly and cursorily, and summed up with new force and weight. 2. The moving the passions, which is so peculiar to the peroration, that the masters of the art call this part sedes affectuum. The passions to be raised are various, according to the various kinds of oration. In a panegyric, love, admiration, emulation, joy, &c. In an invective, hatred, contempt, &c. In a deliberation, hope, confidence, or fear. The qualities required in the peroration are, that it be very vehement and passionate, and that it be short; because, as Cicero observes, tears soon dry up.

PEROTIS, in botany, a genus of the Triandria Digynia class and order. Essential character: calyx none; corolla two-valved; valves equal, awned. There are two species, *viz.* P. latifolia, and P. polystachya, both natives of the East Indies.

PERPENDICULAR, in geometry, a line falling directly on another line, so as to make equal angles on each side; called also a normal line. See GEOMETRY.

PERPENDICULAR *to a parabola*, is a right line cutting the parabola in the point in which any other right line touches it, and is also itself perpendicular to that tangent.

PERPETUAL *screw*, is one which is acted upon by the teeth of a wheel, and which continues its action for an indefinite length of time, or as long as the teeth of the wheel continue to act upon it.

PERPETUITY, in the doctrine of annuities, is the number of years in which the simple interest of any principal sum will amount to the same as the principal itself; or, it is the number of years' purchase to be given for an annuity which is to continue for ever; and it is found by dividing 100*l.* by the rate of interest agreed upon: thus, allowing 5 per cent. the perpetuity is $£\frac{100}{5} = 20$; and at the rates usually adopted, the perpetuity is as follows:—

At 3 per cent. $\frac{100}{3} = 33.333$, &c.

$3\frac{1}{2}$ . . . . . $\frac{100}{3.5} = 28.57$, &c.

4 . . . . . $\frac{100}{4} = 25$.

$4\frac{1}{2}$ . . . . . $\frac{100}{4.5} = 22.22$, &c.

5 . . . . . $\frac{100}{5} = 20$.

6 . . . . . $\frac{100}{6} = 16.66$, &c.

7 . . . . . $\frac{100}{7} = 14.28$, &c.

8 . . . . . $\frac{100}{.8} = 12.5$.

These are the number of years' purchase to be given for a perpetual annui-

ty, on the supposition that it is receivable yearly.

Perpetuity, in law, is where, if all that have interest join in the conveyance, yet they cannot bar or pass the estate; for, if by concurrence of all having interest, the estate may be barred, it is no perpetuity.

PERRY, a drink made of pears, in the same manner as cyder is made from apples. See Cyder. The pears must be perfectly ripe, and to give the liquor a greater degree of tartness, some mix crabs with them. The best fruit for making perry is such as is least fit for eating, as the choak-pear, boreland-pear, horse-pear, and the barberry-pear.

PERSEUS, in astronomy, a constellation of the northern hemisphere, which, according to the catalogues of Ptolemy and Tycho, contains twenty-nine stars; but in the Britannic catalogue, sixty-seven.

PERSIAN *wheel*, an engine, or wheel, turned by a rivulet, or other stream of water, and fitted with open boxes at its cogs, to raise water for the overflowing of lands, or other purposes. It may be made of any size, according to the height the water is to be raised to, and the strength of the stream by which it is turned. This wheel is placed so, that its bottom only is immersed in the stream, wherein the open boxes at its cogs are all filled one after another with water, which is raised with them to the upper part of the wheel's circuit, and then naturally empties itself into a trough, which carries it to the land.

PERSON, in dramatic poetry, the character assumed by an actor, or he who is represented by the player. Thus, at the head of dramatic pieces, is placed the dramatis personæ, or list of the persons that are to appear on the stage. Father Bossu observes, that in the epic and dramatic poem, the same person must reign throughout; that is, must sustain the chief part through the whole piece, and the characters of all the other persons must be subordinate to him.

Person, in grammar, a term applied to such nouns or pronouns, as being either prefixed or understood, are the nominatives in all inflexions of a verb; or it is the agent or patient in all finite and personal verbs. See Grammar.

PERSONAL *tithes*, tithes paid of such profits as come by the labour of a man's person, as by buying and selling, gains of merchandise, and handicrafts, &c.

PERSONALITY, an action is in the personality, where it is brought against the right person, or the person against whom in law it lies.

PERSONATE, in law, is the representing a person by a fictitious or assumed character, so as to pass for the person represented. Personating bail, is by stat. 21 Jac. I, c. 26, a capital felony. By various other statutes, personating seamen entitled to wages, prize-money, &c. is also a capital felony.

PERSONATÆ, in botany, *masked*, the name of the fortieth order in Linnæus's Fragments of a Natural Method, consisting of a number of plants whose flowers are furnished with an irregular gaping petal, which, in figure, somewhat resembles the snout of an animal. Most of the genera of this natural order arrange themselves under the class and order "Didynamia Angiospermia." The rest, although they cannot enter into the artificial class just mentioned, for want of the classic character, (the inequality of the stamina), yet, in a natural method, which admits of greater latitude, may be arranged with the Personatæ, which they resemble in their habit and general appearance, and particularly in the circumstance expressed in the title. This order furnishes both herbaceous and woody vegetables of the shrub and tree kind. The roots are generally fibrous and branched; in gerardia and tozzia, they are tuberous. The roots of broom-rape are parasitical; that is, attach themselves to the roots of other plants, from which they derive their nourishment. The stems and branches are cylindrical when young, except in some species of fig-wort, in which they are square. The leaves are simple, generally placed opposite in pairs at the bottom of the branches, but in many genera, stand alternate towards the top. Some species of trumpet-flower have the common footstalk of their winged leaves terminated by a tendril, with three or five branches. In a species of cornutia is observed a stipula or scale, in form of a half-moon, of the same substance with the leaves between which it is placed. The flowers are universally hermaphrodite. They proceed either singly, or in clusters, from the wings of the leaves, as in American viburnum, or terminate the branches in a spike, panicle, or head, as in cornutia, vervain, &c. In the latter they seem placed in whorls. The calyx, or flower-cup, is of one leaf, which is cut into two, three, four, or five divisions, that are permanent. In the trumpet-flower, the calyx falls off early, and generally resolves itself into five distinct leaves. The corolla is com-

posed of one irregular petal, with two lips, resembling the head or snout of an animal. In toad-flax, the petal is terminated behind by a nectarium in form of a spur. The stamina in plants of the first section, are two or four in number. In hedge-hyssop, and some species of vervain, the filaments are four in number, but two of these only are terminated by anthers; so that the number of perfect stamina in these plants is only two. The seed-bud is single, and placed above the receptacle of the flower. The style is single, thread-shaped, bent in the direction of the stamina, and crowned with a stigma, which is generally blunt, and sometimes divided into two. The seed-vessel is a capsule, generally divided internally into two cavities, and externally into the same number of valves. The seeds are numerous, and affixed to a receptacle in the middle of the capsule.

PERSOONIA, in botany, so named in honour of C. H Persoon; a genus of the Tetrandria Monogynia class and order. Essential character: calyx none; petals four, staminiferous towards the base; glands four at the base of the germ; stigma blunt; drupe one-seeded. This genus consists of subvimineous shrubs; leaves commonly alternate, without stipules; corolla smooth within: anthers linear, finally bent back; style permanent, smooth; drupe eatable in most; flowers yellow. Natives of the islands in the Southern Ocean.

PERSPECTIVE is the foundation of all the polite or liberal arts that have their basis in drawing; though colouring, taken abstractedly, does not come within its rules, yet the painter, as well as the sculptor and architect, cannot but derive essential advantages from a knowledge of perspective; it is indeed difficult to conceive how a person, who has not either been instructed in, or been gifted by nature with some idea of the effects produced by locality and distance, can form any thing like a correct opinion of the merits of those imitations of nature which come under the heads of portrait, landscape, figure, or architectural drawing.

Perspective is, in brief, the art of representing, upon a plane surface, the appearance of objects, however diversified, similar to that they assume upon a glass-plane, interposed between them and the eye at a given distance. The representation of a solid object on a plane surface can shew the original in no other point of view but that from which it is at the time beheld by the draughtsman; the least change in any of the parts requires a change in the whole; unless in fancy drawings, where a fac-simile is not required. Nor can any deviation from the several lines, which will be hereafter explained, and on which the truth and correctness of representation depend, be allowed, without changing the bearings, directions, and tendency of all the perspective lines, which constitute the basis of that faithful and converging series which unite all the component parts in the most pleasing and harmonious concinnity.

By perspective we are taught to delineate objects on a plane, upon geometrical principles, and in exact ratio with their several magnitudes, governed by their distance. But it is not in the power of art to represent any single figure, (exact as it appears in nature), on a plane, except it be a circle; and then the point of sight, or direct position of the eye, must be perfectly central. The reasons for this are obvious; every object which recedes from the eye, (such as a row of houses in an oblique direction), inevitably requires that its more remote parts should be represented as being of less magnitude than those more in front, that is, nearer to the spectator. Now, although it is considered an axiom in perspective that all objects standing parallel to the base line, or bottom of the picture, should be represented as preserving in every instance the real proportions of the scale from which their parts were taken; yet when we analyze the object, according to the various angles those several parts make with the eye, we shall find that even such full pointing figures require their more remote parts to be reduced in proportion as they become more distant from the centre, or point of sight. But it will be obvious, that where the object is very remote, there must be the less necessity for such scrupulous attention; therefore, when we draw an extensive mansion, full fronting, at a great distance, we describe all the horizontal lines in the building by horizontal lines in the drawing; so long as they are comprehended within an angle of 60 degrees; which is the natural range of sight, and beyond which no picture should ever extend; when beyond that angle, we cannot take the whole picture at one view; but must treat it as a panorama, and view the several parts abstractedly. When a building is so near as to occasion turning our heads round for the purpose of seeing its several

parts, they have the same effect, and compel us to have recourse to various vanishing points, in which we seek the termination of those lines that converge, and in fact divide the building, though full fronted and uniform, into several parts; each of which seems to assume a distinct character, and to demand separate consideration This will be more fully understood when we treat of the general rules which govern perspective. The reader must recollect, that, as it would be impossible to represent more than one view of the object, in one plane, or picture, so there can be but one point of sight; that is, but one particular spot, where the eye of the spectator is supposed to be fixed; from which, as from a very minute point, all the figures represented must appear as under one general system. The same attention must of course be paid to shadows; for we cannot suppose the dark side of a house to result from any thing but the light being in such a quarter as does not allow it to strike on that side; consequently we attribute the bright side of the same object to its being illuminated by the rays which act peremptorily upon it. Speaking of common effects, we consider the light to be solitary; such as the Sun, or the Moon, or one candle, &c.; hence we perceive both the necessity, and the reason, for exhibiting all objects as bright, which are within the range of, or shew themselves openly to, the light, and all parts to which its rays cannot reach direct, as being in the shade and more or less dark according as they may be more retired and confined. When two lights are found in the same picture, such as two candles on a table, there will be to every object under their mutual influence a half shade, and a whole shade; the former called the penumbra, shewing that extent which results from one light being obscured, or cut off; and the latter, or the umbra, shewing those parts which are not acted upon by either of the lights. This will be obvious to any person who may place two candles behind him, as he sits with his back to a table; they being about two feet asunder. He will then see, on the wall, the influence of each candle; and his shadow will increase with the remoteness of the plane, or wall, on which it is represented.

The following definitions of the principal features in the science and application of perspective will prove useful to the student, *viz.* projection delineates objects in plano, by means of right lines called rays, supposed to be drawn from every angle of the object to particular points. When the objects are angular, these rays necessarily form pyramids, having the plane or superficies, whence they proceed, for their basis; but when drawn from, or to, circular objects, they form a cone.

Ichnography, or ichnographic projection, is described by right lines parallel among themselves, and perpendicular to the horizon, from every angle of every object, on a plane parallel to the horizon. The points where the perpendicular lines or rays cut that plane being joined by right lines. The figure projected on the horizontal plane is likewise called the plan or seat of that object on the ground plane. The points are the scites, or seats, of the angles of the object. The lines are the seats of the sides. By this we are to understand how the basis of figures represented as superstructures stand, or are supported; and we are further enabled to judge of, indeed to measure, their several parts, and their areas.

Orthography represents the vertical position and appearance of an object; hence orthographic projection is called the elevation. When we thus see the front of a house, we give it that term; but when the side is displayed, we call it the profile. If we suppose a house, or other object, to be divided by a plane passing perpendicularly through it in a line at right angles with the point, we call it the lateral section; but if the plane pass in a direction parallel with the front, it is termed a longitudinal section. If the plane passes in neither of the former directions (not however deviating from the vertical) it is said to be an oblique section.

These give us the modes of laying down plans, of shewing the parts, and the manner in which the interiors of edifices are arranged; consequently are indispensable to the architect, surveyor, and indeed should be understood by every person in any way connected with building, or designing. Nor should the following be neglected, *viz.* scenography, which shews us how to direct the visual rays to every point, or part, of a picture; and stereography, which enables us to represent solids on a plane, from geometrical projection; whence their several dimensions, *viz.* length, breadth, and thickness, may all be represented, and be correctly understood at sight.

PERSPECTIVE.

We suppose our readers to have some knowledge of geometry before they commence upon this, or any other of the abstract sciences which are founded thereon. Should such, however, not be the case, we beg leave to refer them to that head, where they will find sufficient instruction to enable them to prosecute their inquiries on the subject now before us.

An original object, is that which becomes the subject of the picture, and which is the parent of the design. Any plane figure may become an object, as may any of its parts, as a broken pillar, the ruins of a house, the stump or the branch of a tree; but we generally speak of objects as relating to entire figures represented as solids, or to as much rural or other scenery as may be embraced under an angle of 60 degrees formed by two lines meeting at the eye. This will explain why we are enabled to represent so great a number of distant objects, while the front, or fore-ground, will contain, comparatively, but a very few: it being obvious, that as the lines forming the angle become more distant, the more may be included between them.

Original planes, or lines, are the surfaces of the objects to be drawn; or they are any lines of those surfaces; or it means the surfaces on which these objects stand.

Perspective plane is the picture itself, which is supposed to be a transparent plane, through which we view the objects represented thereon.

Vanishing planes are those points which are marked upon the picture, by supposing lines to be drawn from the spectators's eye parallel to any original lines, and produced until they touch the picture.

Ground plane is the surface of the earth, or plane of the horizon, on which the picture is supposed to stand.

The ground line is that formed by the intersection of the picture in the ground plane.

The horizontal line is the vanishing point of the horizontal plane, and is produced in the same manner as any other vanishing line, *viz.* by passing a plane through the eye parallel to the horizontal plane.

The point of sight is the fixed point from which the spectator views the perspective plane.

Vanishing points are the points which are marked down in the picture, by supposing lines to be drawn from the spectator's eye, parallel to any original lines, and produced until they touch the picture.

The centre of a picture is that point on the perspective plane where a line, drawn from the eye perpendicular to the picture, would cut it; consequently it is that part of the picture which is nearest to the eye of the spectator.

The distance of the picture is the distance from the eye to the centre of the picture. If what has been already said and repeated, regarding the angle of 60 degrees, is understood, the spectator will never bring the picture so near to himself as to occasion the eyes to expand, indeed to strain, so as to embrace more than that angle.

The distance of a vanishing point is the distance from the eye of the spectator to that point where the converging lines meet, and after gradually diminishing all the objects which come within their direction and proportion, are reduced so as in fact to terminate in nothing. All parallel lines have the same vanishing point; that is to say, all such as are in a building, parallel to each other, when not represented exactly opposite to, and parallel with the eye, will appear to converge towards some remote point, *i. e.* their vanishing point. Circles, when retiring in such manner, are represented by ellipses, proportioned to their distances: their dimensions in perspective are ascertained by enclosing them, or the nearest of them, where a regular succession is to be pourtrayed within a square, which being divided into any number of equal parts or chequers, will show all the proportions of those more remote. We trust it scarcely requires to be repeated, that the further any object is from the eye or foreground of a picture, the less it will appear in nature, and the more it must be reduced in exhibiting its perspective.

A bird's-eye view is supposed to be taken from some elevated spot, which commands such a prospect as nearly resembles the plane or ichnography of the places seen. Thus the view from a high tower, or from a mountain, whence the altitudes of the several objects on the plane below appear much diminished, gives nearly the same representation as is offered to a bird flying over them; whence the term. Some idea may be formed of this by standing on any height, and observing how low those objects, which are near thereto, will appear, when compared

with those more distant, taking, however, the perspective diminution of the latter into consideration.

We shall now explain the five figures included in the Plate of Perspective. The first figure shews a base line, A B, divided into eight equal parts, whose perspective proportions on the lines, A C and B C, are shewn, by drawing, from the several divisions, 1, 2, 3, 4, &c. on A B, rays to the vanishing points, D and E, situated on the horizon. If A C and B C were of equal length, the several squares thus made in the area, A C B, would shew trapezia regularly diminishing towards C, having their opposite angles intersectable by perpendiculars from the base line, A B, and the other opposite angles intersectable by horizontal lines parallel to A B. But A C being longer than B C, gives the whole of the trapezia a cast towards E. This shews that the two vanishing points, while, (in this instance) they serve to intersect each other, contain distances, considered perspectively, in proportion to their brevity; they are under the same parallels, but the angle, B A C, being smaller than the angle C B A, causes the divisions on A C to be more extensive than those on B C, as may be seen by referring to the lesser spaces occupied by the standard on the latter. The figures 1, 2, 3, &c. correspond with those on the base line, exhibiting their due perspective distances on the lines A C and B C. It will also be observed, that as the trapezia become more distant, they become smaller, while their angles pointing towards C, and towards the base line, that is, their perpendicular angles become more obtuse, and their horizontal angles, *i. e.* those on the right and left, become more acute: were it otherwise, they could not produce a diminution of the trapezia in proportion to distance.

Fig. 2, shews the angle formed by two ranges of buildings, each of which has a different vanishing point. N O is the perpendicular edge of the angle; N Q O, and N P O, shew the two faces, each of which is intersected by streets of various breadths. In both instances the spectator's eye is supposed to be situated near two-thirds up the two buildings; that is to say, about X on one face, and about W on the other. This produces a mixed effect, seldom to be found in reality; though in some cases, where streets lying on a declivity, and joining others with less deviation from the level, this will be produced. The mode of proving the due direction of lines in perspective, such as X Q, and W P, which appear like the bands or fillets that separate the different stories of an edifice, is very simple; namely, all horizontal lines in buildings that decline from the plane of a picture, and tend towards some vanishing point, will, when above the spectator's eye, appear to descend towards that point, as from N to Q; but when below the spectator's eye, they will appear to rise as O Q. The triangle O Q N being more acute will give a more direct view of the houses, and appear to recede less from the eye than N P Q, which is more obtuse, and makes every house appear narrower.

Fig. 3, shews the front of a house, I H F G, which, when thrown into perspective by the vanishing point, Q, being made high, and several rays proceeding from *o p q r s t* to *k* being carried too high, give an *outré* appearance to the front, as shewn by the outlines I F L M, in which it will be seen that a rude and unpleasant disproportion is given in every part. Nor is this even the manner in which the house would appear when seen from above, or below it; on the principle of a bird's eye view. The places of the several doors and windows being ascertained, the several lines, *o p q r s t*, intersect the ground-line F M in those parts which correspond with the places of the doors; whose heights are ascertained or determined by the line S Q, equal at S F to their height in the original front I H F G.

The windows being over the doors, must be under the same perpendiculars in both cases; their depth is determined by taking the measurements on the line I S, and drawing rays to the point Q. This figure is given chiefly with the intention of shewing the immense disproportions which are generated by a false placing of the point to which the rays proceed; and which point is always formed to advantage rather below than above the centre of a picture. When the horizon is too much raised, numberless distortions take place.

Fig. 4, gives the ground plan of a gallery, R S V T, which is to be shewn in perspective with its several standards, and the pitch of the awning on the ground lines V X and W X. Here Π Φ becomes the horizontal line, on which X is the vanishing point, and Φ the point to which the rays R Φ, 9 Φ, 10 Φ, and W Φ, being drawn, cut V X in the places marked 4, 3, 2, 1, respectively, and give the situations of the standards for the right side. The places for those on the left side are found by drawing the lines 4, 5; 6, 3;

7, 2; 8, 1; all parallel to W V. In this instance all the intervals, R, 9; 9, 10; 10, W; and W, V; being equal, the proximate superior ray will always give that parallel: thus the ray of R Φ cuts X W exactly at the point 6, which gives the line 6, 3, parallel to 7, 2; and so of all in succession. The lines Y Z and W V are parallel; they determine the height of the front standards, and by means of the lines Y X and Z X cut the other standards at their proper heights. Their descent towards X shew them to be above the line Π Φ, which is level with the spectator's eye. The summits of the couples are ascertained by the line △ X. They will all have their centres over the centres of the lines 5, 4; 6, 3; 7, 2; and 8, 1: ascertained by drawing a line from B to X.

Fig. 5, exhibits the wall of a monastery, supported in some parts by reinforcements, or pillars, between which the wall is less substantial. The measurement of the pillars and of the intervals is given on the base-line A B, while G F shews the horizon and line of sight. The rays from *a*, *c*, *e*, and *g*, shew the places where the several divisions take place on the ground-line A E, and shew the projections of *b*, *d*, *f*, *h*. The upper line is also determined by C D, and the crosses in like manner are made to diminish towards the vanishing point F. The small mark at A in the middle of the wall's thickness, as shewn by the shaded part, gives rule for each projection of the several pillars, as shewn by the shaded parts: their summits and bases will, however, have their fronts, *i. e.* the parts parallel with C A, terminated by horizontal lines parallel with A B. We must once more impress, that all fronting horizontals in nature must be so represented in perspective, provided they do not extend beyond 60°; also, that in every instance perpendiculars in nature are so delineated in perspective.

The reader will have seen, that the base-line, and the depth below it, give the measure of the figure when obliqued. To render this more perfectly intelligible, let us say that it were necessary to place the square W, V, 13, T in perspective between W, V and X (fig. 4). This being a square is readily done; the more so, as it is proximate to the line; because the quadrant T W is so readily acted upon; W V being equal to V T. But say that it were needful to place the line T K (fig. 4) in perspective on the line V X. Draw the quadrant T, W; and the quadrant K, 10; the line W, 1, drawn to Φ, will shew the place of T, and the line 8, 2, will shew the place of K: therefore the line T K will be found in perspective between the points 1 and 2 on the line V X. Thus any line or object may be represented; observing that the distance at which it stands below the base-line must be measured on the base-line; when, by drawing rays to the horizontal line, (whereon all the vanishing points must rest) its place on the oblique line, or scite, will be determined. Some authors on this subject have directed that the back ground should be limited by a semicircle, describing the half-horizon, and that all the vanishing points ought to be placed thereon. This, however well it may answer in a panoramic point of view, can never be so appropriate as the horizontal line, in a picture which includes only the sixth part of a circle.

What has been said relates entirely to mathematical perspective, and forms the basis of architectural design, and governs (though rather occultly) every kind of landscape painting: with regard to the perspective of living objects, and of varied nature, that can only be acquired by attention to models, and to the real figures.

Perspective, *aerial*, is the art of giving a due diminution or degradation to the strength of the light, shade, and colours of objects, according to their different distances, the quantity of light which falls on them, and the medium through which they are seen.

As the eye does not judge of the distance of objects entirely by their apparent size, but also by their strength of colours, and distinction of parts: so it is not sufficient to give an object its due apparent bulk according to the rules of stereography, unless at the same time it be expressed with that proper faintness and degradation of colour which the distance requires. Thus if the figure of a man, at a distance, were painted of a proper magnitude for the place, but with too great a distinction of parts, or too strong colours, it would appear to stand forward, and seem proportionally less, so as to represent a dwarf situated nearer the eye, and out of the plane on which the painter intended it should stand.

By the original colour of an object is meant, that colour which it exhibits to the eye when duly exposed to it in a full open uniform light, at such a moderate distance as to be clearly and distinctly seen. This colour receives an alteration from many

causes, the principal of which are the following.

1. From the objects being removed to a greater distance from the eye, whereby the rays of light which it reflects are less vivid, and the colour becomes more diluted and tinged, in some measure, by the faint bluish cast, or with the dimness or haziness of the body of air through which the rays pass.

2. From the greater or less degree of light with which the object is enlightened; the same original colour having a different appearance in the shades from what it has in the light, although at an equal distance from the eye, and so in proportion to the strength of the light or shade.

3. From the colour of the light itself which falls upon it, whether it be from the reflection of coloured light from any adjacent object, or by its passage through a coloured medium, which will exhibit a colour compounded of the original colour of the object, and the other accidental colours which the light brings with it.

4. From the position of the surface of the object, or of its several parts with respect to the eye; such parts of it appearing more lively and distinct than those which are seen obliquely.

5. From the closeness or openness of the place where the object is situated; the light being much more variously directed and reflected within a room, than in the open air.

6. Some original colours naturally reflect light in a greater proportion than others, though equally exposed to the same degrees of it; whereby their degradation at several distances will be different from that of other colours which reflect less light.

From these several causes it happens that the colours of objects are seldom seen pure and unmixed, but generally arrive at the eye broken and softened by each other; and, therefore, in painting, where the natural appearances of objects are to be described, all hard or sharp colouring should be carefully avoided.

A painter, therefore, who would succeed in aerial perspective, ought carefully to study the effects which distance, or the different degrees or colours of light, have on each particular original colour, to know how its appearance or strength is changed in the several circumstances above mentioned, and represent it accordingly; so that, in a picture of various coloured objects, he may be able to give each original colour its own proper diminution or degradation, according to its place.

Now, as all objects in a picture are proportioned to those placed in the front; so in aerial perspective the strength of light, and the brightness of the colours of objects close to the picture, must serve as a standard; with respect to which, all the same colours, at different distances, must have a proportional degradation in like circumstances.

In order, therefore, to give any colour its proper diminution in proportion to its distance, it ought to be known what the appearance of that colour would be, were it close to the picture, regard being had to that degree of light which is chosen as the principal light of the picture. For if any colour should be made too bright for another, or for the general colours employed in the rest of the picture, it will appear too glaring, seem to start out of its place, and throw a flatness and damp upon the rest of the work; or, as the painters express it, the brightness of that colour will kill the rest.

Perspective *glass*, in optics, differs from a telescope in this: instead of the convex eye-glass placed behind the image, to make the rays of each pencil go parallel to the eye, there is placed a concave eye-glass as much before it; which opens the converging rays, and makes them emerge parallel to the eye. The quantity of objects taken in at one view with this instrument does not depend upon the breadth of the eye-glass, as in the astronomical telescope, but upon the breadth of the pupil of the eye.

Reflecting perspective glasses, called by some opera-glasses, or diagonal perspectives, are so contrived that a person can view any one in a public place, as the opera or play-houses, without it being possible to distinguish who it is he looks at. See Opera *glass*.

Perspective *plane*, is the glass, or other transparent surface, supposed to be placed between the eye and the object, perpendicular to the horizon. It is sometimes called the section, table, or glass.

PERSPIRATION, in medicine, the evacuation of the juices of the body through the pores of the skin. Perspiration is distinguished into sensible and insensible. See Physiology.

The skin of man and of animals is pierced with an infinitude of pores, through which, by means of the transpiration, the parts of the aliments escape which do not contribute to nourishment. Independently of the sensible perspiration, which is

called sweat, and which is accidental, there is, moreover, one that is insensible, acting more or less at every instant, and which none could conceive to be so abundant as it is, before the experiments of Sanctorius. This celebrated philosopher had the resolution to pass a part of his life in a balance, wherein he weighed himself, in order to determine the loss occasioned by the effects of the insensible perspiration. He has found that this kind of evacuation causes us to lose, in the space of twenty-four hours, about five-eighths of the nutriment which we have taken. Dodard, in repeating afterwards the same experiments, has had regard to the difference of age, and is convinced that a person perspires much the most in his youth. But the philosophers who have directed their attention to this object, have not sufficiently distinguished the effect of the perspiration or transpiration which is performed by the lungs, and of which the matter escapes by expiration, from the effect which is attributable to the cutaneous perspiration, or to that which obtains through the intermediation of the skin. Seguin has undertaken, in conjunction with Lavoisier, to determine these two effects separately; and after having sought, in the usual manner, the total result of the transpiration, has suppressed that which is performed by the skin, by applying upon that organ a cover impermeable to the humour which it transmits outwardly: thus has been obtained the quantity of the pulmonary transpiration: and the mean between the results of these experiments gives seven-elevenths for the ratio between this quantity and that of the cutaneous perspiration; that is, the effect produced by the pulmonary transpiration is more than the third of the total effect.

PERUKE. It appears that this term was originally applied to describe a fine natural head of long hair; but whatever may have been the ancient use or meaning of the word, it has now almost become obsolete, though it was for more than a century in constant application to those artificial heads of hair, made probably at first to conceal natural or accidental baldness, but which afterwards became so ridiculously fashionable, as to be worn in preference to the most beautiful locks, absurdly shaved off the head to make room for them.

Ancient authors might be quoted to prove that the great and luxurious of that time had recourse to this mode of concealing defects, and of decorating the head; nay, it might perhaps be proved, that the peruke of the Emperor Commodus was more absurdly composed than any modern peruke has ever been; and indeed it must be admitted, that a wig powdered with scrapings of gold, in addition to oils and glutinous perfumes, must have made a more wonderful appearance than our immediate ancestors ever witnessed. It was in the reign of Charles the First, that perukes were introduced throughout Europe, when the moralists attacked them without mercy, as they perceived that the folly of youth even extended to the cutting off nature's locks, to be replaced by the hair of the dead, and of horses, woven into a filthy piece of canvas. Admonition and ridicule was, however, of little avail, and the clergy began to be affected by the general mania. Those on the continent, being almost universally Roman Catholics, were so completely subject to their superiors, that the peruke was soon routed from their body; but as the dignified clergy of England conceive that their consequence is increased by the enormous bushes of hair upon their heads, and the judges have adopted their sentiments in this particular, it is probable many years will elapse before the shape and absurdity of two particular species of perukes are forgotton.

About the close of the seventeenth century the peruke was made to represent the natural curl of the hair, but in such profusion, that ten heads would not have furnished an equal quantity, as it flowed down the back, and hung over the shoulders, half way down the arms. By 1721, it had become fashionable to tie one half of it on the left side into a club. Between 1730 and 1740, the bag-wig came into fashion, and the peruke was docked considerably, and sometimes plaited behind into a queue, though even till 1752 the long flowing locks maintained their influence. After 1770 those were rarely seen; and since that time persons wearing perukes have generally had substantial reasons for so doing from baldness and complaints in the head. At one time, indeed, when the stern virtues of Brutus were much in vogue, the young men of Europe wore perukes of black or dark hair, dressed from his statues. Many particulars on this subject have been preserved by Mr. Malcolm, in his "Anecdotes of the Manners and Customs of London," from which we learn, that a young country-woman obtained 60*l.* for her head of hair in the year

1700, when human hair sold at 3*l.* per ounce; and in 1720, the grey locks of an aged woman sold for 50*l.* after her decease, as did wigs at 40*l.* each, of peculiar excellence.

A petition from the master perukemakers of London and Westminster, presented to the King in 1763, points out the final decline of their use to have taken place at that time. In this they complain of the public wearing their own hair; and say, "That this mode, pernicious enough in itself to their trade, is rendered excessively more so by swarms of French hair-dressers already in those cities, and daily increasing."

PERULA, in botany, a genus of the Dioecia Polyandria class and order. Generic character: male, calyx; perianthum two-leaved, very small corolla; petal one, semi-globular, concave, hanging down; stamens, filaments very many; pistil, germs four, barren, very small: female on a distinct tree; calyx, perianthum as in the male, deciduous; corolla as in the male; pistil, germs four, fertile; pericarpium capsule, obovate, subtrigonal; seeds solitary, small. The number of species not known. P. arborea is a native of New Granada, about Mariquita, where it was found by Mutis.

PETALOMA, in botany, a genus of the Decandria Monogynia class and order. Essential character: calyx goblet-shaped, five-toothed; petals five, inserted between the teeth of the calyx; stamina on the margin of the calyx; berry one-celled; seeds one or four. There are two species, *viz.* P. myrtilloides and P. mouriri.

PETESIA, in botany, a genus of the Tetrandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla one-petalled, funnel-form; stigma bifid; berry many-seeded. There are three species.

PETIOLUS. See Pedunculus.

PETIT (Peter) a considerable mathematician and philosopher of France, was born at Montlucon in the diocese of Bourges, in the year 1589, according to some, but in 1600 according to others. He first cultivated the mathematics and philosophy in the place of his nativity; but in 1633 he repaired to Paris, to which place his reputation had procured him an invitation. Here he became highly celebrated for his ingenious writings, and for his connections with Pascal, Des Cartes, Mersenne, and the other great men of that time. He was employed on several occasions by Cardinal Richelieu; he was commissioned by this minister to visit the seaports, with the title of the King's Engineer; and was also sent into Italy upon the King's business. He was at Tours in 1640, where he married; and was afterwards made Intendant of the Fortifications. Baillet, in his Life of Des Cartes, says that Petit had a great genius for mathematics; that he excelled particularly in astronomy; and had a singular passion for experimental philosophy. He was intimately connected with Pascal, with whom he made, at Rouen, the same experiments concerning the vacuum, which Torricelli had before made in Italy; and was assured of their truth by frequent repetitions. He died August the 20th, 1667, at Lagny, near Paris, whither he had retired for some time before his decease. He published several works upon physical and astronomical subjects, also on chronology and theology.

PETITIA, in botany, so named in memory of Francis Petit, a genus of the Tetrandria Monogynia class and order. Natural order of Vitices, Jussieu. Essential character: calyx four-toothed, inferior; corolla four-parted; drupe with a two-celled nut. There is but one species, *viz.* P. Domingensis, a native of the island of St. Domingo.

PETITION, no petition to the King, or to either house of parliament, for any alteration in church or state, shall be signed by above twenty persons, unless the matter thereof be approved by three Justices of the Peace, or the major part of the Grand Jury in the county; and in London, by the Lord Mayor, Aldermen, and Common Council: nor shall any petition be presented by more than ten persons at a time.

Petition *in chancery*, a request in writing, directed to the Lord Chancellor, or Master of the Rolls, shewing some matter or cause whereupon the petitioner prays somewhat to be granted him.

PETIVERIA, in botany, *Guinea-hen weed*, a genus of the Hexandria Tetragynia class and order. Natural order of Holoraceæ. Atriplices, Jussieu. Essential character: calyx four-leaved; corolla none; seed one, with reflex awns at top. There are two species, *viz.* P. alliacea, common Guinea hen-weed; and P. octandra, dwarf Guinea hen-weed: both natives of the West Indies.

PETREA, in botany, so named in honour of Lord Petre, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Vitices, Jussieu. Essential character: calyx five-

parted, very large, coloured; corolla wheel shaped; capsule two-celled, at the bottom of the calyx; seeds solitary. There is but one species, *viz.* P. volubilis, a native of South America and the West Indies.

PETRIFACTION. See ORYCTOLOGY.

PETROCARYA, in botany, a genus of the Heptandria Monogynia class and order. Natural order of Pomaceæ. Rosaceæ, Jussieu. Essential character: calyx turbinate, five-cleft, with two bractes at the base; corolla five-petalled, less than the calyx; filaments fourteen, seven of which are barren; drupe inclosing a two-celled nut, with a stony shell. There are two species, *viz.* P. montana, and P. campestris, both found in the woods of Guiana, where they grow to the height of forty and eighty feet.

PETROLEUM, in chemistry. The substances which mineralogists have distinguished by the names of asphaltum, maltha, petroleum, and naptha, are thought by Mr. Murray, and others, to be mere varieties of one species, and form a series which passes even into coal. Asphaltum forms the connection with pitch-coal. It is found in veins, and in small masses, and also sometimes on the surface of lakes. Maltha is softer, has a degree of tenacity, and a strong bituminous smell. Petroleum is semi-liquid, semi-transparent, of a reddish-brown colour, and fetid odour. Naptha is of a lighter colour, more or less transparent, perfectly thin and liquid, light, odoriferous, volatile, and inflammable. Naptha by inspissation becoming petroleum, and this passing into asphaltum. See ASPHALTUM, BITUMEN, &c.

In several parts of France petroleum is found floating on the water, and is known in commerce by the name of oil of Gabian. Wells are sometimes dug 100 feet deep, where the petroleum is found mixed with the soil, in such proportion that ten pounds may be extracted from a hundred weight.

PETROMYZON, the *lamprey*, in natural history, a genus of fishes of the order Cartilaginei. Generic character: body shaped like an eel; mouth beneath, with numerous teeth, in circular rows; seven spiracles on each side the neck; no pectoral or ventral fins. Shaw notices nine species, and Gmelin only four. P. marinus, or the great lamprey, is usually of a brown olive colour, tinged with yellowish white. It is often three feet long; is an inhabitant of the seas, as its name indeed implies; but in the beginning of spring ascends rivers, in which it resides for a few months, then returning to the ocean. It is viviparous, and supposed to subsist almost entirely on worms and fishes. Its heart is enclosed not in a soft but in a cartilaginous pericardium, constituting thus a singular deviation from the general structure of animals. Its spine also possesses the peculiarity of being rather a soft cartilage than bone. These fishes fasten themselves with the jagged edges of the mouth to large stones, with the most extraordinary firmness, and may be lifted by the tail to a considerable height, without being made to quit a stone of the weight of even ten or twelve pounds. Their principle of vitality is extremely vigorous and persevering, various parts of the body long continuing to move for some hours after it is divided; and the head will adhere to a rock for hours after the greater part of the body is cut away. In some large rivers of Europe, these fishes are taken in vast numbers, and preserved with spices and salt as an article for merchandise. In England, the Severn is the most celebrated river for them, and they are much valued on their first arrival from the sea. They are considered a high luxury for the table, and the life of one of the Kings of England will be recollected to have been terminated by his excessive partiality to potted lampreys.

P. fluviatilis, or the lesser lamprey of Europe, is about twelve inches long, inhabits also the sea, but is found more frequently in the rivers than the former. It abounds in the Thames and Severn, and is preferred by many to the larger species, as being not so strong in taste. In some years half a million of these fishes have been sold from the neighbourhood of Mortlake, for the Dutch cod and turbot fishery, at the rate of two pounds per thousand. In many parts of Germany they are fried and packed up in barrels with spices and bay leaves, and are conveyed to very distant regions, where they are in high estimation, and sell for considerable prices. These fishes will live many days out of the water. In Russia they are taken from beneath the ice, packed in snow, and exported to great distances, and will generally recover themselves on being afterwards thrown into the water. The planer lamprey is ten inches long, will live immersed in spirits of wine for fourteen minutes, moving during that time with incessant violence. The leech lamprey is a native of the river Seine, and will fix on the bellies of va-

rious fishes, particularly the shad, sucking their blood.

PETTY, (Sir William), a singular instance of a universal genius, was the elder son of Anthony Petty, a clothier at Rumsey in Hampshire, England, where he was born in the year 1623. While a boy he took great delight in spending his time among the artificers, whose trades he could work at when but 12 years of age. At the age of 15 he was master of the Latin, Greek, and French languages, with arithmetic, and those parts of practical geometry and astronomy useful in navigation. Soon after he went to the University of Caen in Normandy; and after some stay there he returned to England, where he was preferred in the king's navy. In 1643, he went into the Netherlands and France for three years; and having vigorously prosecuted his studies, especially in physic, at the Universities of Utrecht, Leyden, Amsterdam, and Paris, he returned home. In 1647, he obtained a patent to teach the art of double writing for seventeen years. In 1648, he published at London, "Advice to Mr. Samuel Hartlib, for the advancement of some particular parts of learning." At this time he adhered to the prevailing party of the nation; and went to Oxford, where he taught anatomy and chemistry, and was created a Doctor of Physic, and grew into such repute, that the philosophical meetings, which preceded and laid the foundation of the Royal Society, were first held at his house. In 1650, he was made Professor of Anatomy there; and soon after a member of the College of Physicians in London, as also Professor of Music at Gresham College, London. In 1652, he was appointed Physician to the army in Ireland; as also to three Lord Lieutenants successively, Lambert, Fleetwood, and Henry Cromwell. In Ireland he acquired a great fortune, but not without suspicions and charges of unfair practices in his offices. After the rebellion was over in Ireland, he was appointed one of the commissioners for dividing the forfeited lands to the army who suppressed it. When Henry Cromwell became Lieutenant of that kingdom, in 1655, he appointed Dr. Petty his secretary, and clerk of the council: he likewise procured him to be elected a burgess for West Loo in Cornwall, in Richard Cromwell's parliament, which met in January, 1658. But, in March following, Sir Hierom Sankey, member for Woodstock in Oxfordshire, impeached him of high crimes and misdemeanors in the execution of his office. This gave the doctor a great deal of trouble, as he was summoned before the House of Commons; and notwithstanding the strenuous endeavours of his friends, in their recommendations of him to Secretary Thurloe, and the defence he made before the House, his enemies procured his dismission from his public employments in 1659. He then retired to Ireland till the restoration of King Charles the Second; soon after which he came into England, where he was very graciously received by the king, resigned his professorship at Gresham College, and was appointed one of the commissioners of the Court of Claims. Likewise, April the 11th, 1661, he received the honour of knighthood, and the grant of a new patent, constituting him surveyor-general of Ireland, and was chosen a member of parliament there.

Upon the incorporating of the Royal Society, he was one of the first members, and of its first council. And though he had left off the practice of physic, his name was continued as an honorary member of the College of Physicians in 1663. About this time he invented his double-bottomed ship, to sail against wind and tide, and afterwards presented a model of this ship to the Royal Society; to whom also, in 1665, he communicated "A Discourse about the Building of Ships," containing some curious secrets in that art. But, upon trial, finding his ship failed in some respects, he at length gave up that project.

In 1666, Sir William drew up a treatise, called "Verbum Sapienti," containing an account of the wealth and expenses of England, and the method of raising taxes in the most equal manner. He was well acquainted with the general principles of political arithmetic, and studiously promoted many projects highly useful to his country. It must, however, be admitted that he was equally attentive to his own interests. Thus, at sixty, he writes that his thoughts were fixed upon improving his lands in Ireland, and to promote the trade of iron, lead, marble, fish, &c. of which his estate is capable. As for studies and experiments, "I think now," says he, "to confine the same to the anatomy of the people, and political arithmetic; as also the improvement of ships, land carriages, guns, and pumps, as of most use to mankind." He died in December, 1687, leaving behind him wealth to the amount of about 15,000*l.* per ann. His works were very numerous, some of which are well known, and frequently referred to by authors in the present day.

PETTY *bag*, an office in Chancery, the three clerks of which record the return of all inquisitions out of every county, and make all patents of comptrollers, gaugers, customers, &c.

PETUNSE, in the arts, one of the principal substances made use of in the manufacture of porcelain: the other is kaolin. Petunse consists of

Silex	74
Alumina	14.5
Lime	5.5
	94.0

Kaolin consists of

Silex	74
Alumina	16.5
Lime	2
Water	7
	99.5

Therefore the two together consist of silex and alumina, with less than 5 per cent. of lime. See PORCELAIN.

PEUCEDANUM, in botany, *sulphur-wort*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: fruit ovate, striated on both sides, girt with a membrane; involucres very short. There are eleven species, of which P. officinale, common sulphur wort, has a perennial root, dividing into many strong fibres, running deep into the ground; leaves from the root branching into five parts, and these again into three, each of these divisions sustaining three narrow leaflets, which, when bruised, emit a strong scent like sulphur; foot-stalks channelled; stems nearly two feet in height, channelled, and dividing into two or three branches, each terminated by a large, regular umbel of yellow flowers, composed of several small umbels. It is a native of the southern parts of Europe, in moist meadows.

PEWTER, a factitious metal, used in making domestic utensils, as plates, dishes, &c. The basis of this metal is tin which is converted into pewter, by mixing at the rate of an hundred weight of tin, with fifteen pounds of lead, and six pounds of brass. Besides this composition, which makes the common pewter, there are other kinds compounded of tin, regulus of antimony, bismuth, and copper, in several proportions.

PEZIZA, in botany, a genus of the Cryptogamia Fungi class and order. Generic character: fungus bell-shaped, sessile, concealing lens-shaped seed-bearing bodies; plant concave; seeds on the upper surface only; discharged by jerks. Of this genus of fungus, Linnæus has eleven species, and Dr. Withering no less than forty British species in his arrangement.

PHACA, in botany, *bastard vetch*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: legume half, two-celled. There are eleven species.

PHÆTHUSA, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Essential character: calyx subcylindric, many-leaved, with unequal, recurved scales; florets hermaphrodite, several in the disk; females one or two in the ray; receptacle chaffy; seeds hispid, without any proper down. There is but one species, *viz.* P. Americana, a native of Virginia.

PHÆTON, the *Tropic bird*, in natural history, a genus of birds of the order Anseres. Generic character: bill sharp-edged and pointed; compressed, and slightly sloping down; nostrils pervious and oblong; four toes all webbed together; tail wedge-formed, the two middle feathers extending far beyond others. There are three species: P. æthereus, the common tropic bird, is of the size of a wigeon, and the two middle feathers of the tail measure a foot and a half at least. These birds are always found within, or at least very near, the tropics. They frequently soar to a prodigious height, but generally are near the surface of the water, watching the movements of the flying fish, whose escape from the pursuit of the shark, porpoise, and other enemies beneath, is attended with destruction from the frigate, or man of war bird, the pelican, and tropic bird above. They occasionally repose upon the backs of the drowsy tortoises, as the latter float upon the water, and in these circumstances are taken with the greatest ease. They build in the woods, and will perch on trees. They shed their long feathers every year, and the natives of the Sandwich islands, where the tropic birds abound, pick them up in great abundance in various parts, and consider them as an elegant material in their curious and elaborate dresses, particularly in their mourning suits. These birds are not admired for food.

PHALANGIUM, in natural history, a

genus of insects of the order Aptera. Mouth with horny mandibles, the second joint with a sharp, moveable, cheliferous tooth; feelers filiform; no antennæ; two eyes on the crown, and two at the sides; eight legs; abdomen generally rounded. Of all the insects in this order, few are more repulsive than those of the Phalangium genus, of which there are about twenty species. Some of them are armed with weapons resembling those of the spider genus, but operating with greater malignity. They differ in size, some being very minute, while others are equal in magnitude to the larger kind of spiders. This genus is divided into two sections. A. Mouth with a conic, tubular sucker. B. Mouth without a sucker. The former is sub-divided into sub-sections, *viz. a.* Four-feelers, the upper ones chelate. *b.* Two feelers. In the latter, there are two sub-sections, *viz. a.* Feelers projecting incurved. *b.* Feelers thick, spinous, and furnished with a claw at the tip. P. reniforme, feelers serrate; fore-legs very long and filiform; thorax kidney-shaped: this is one of the largest of the genus: it is a native of the hotter regions of the globe, being found in Africa and South America. This insect is of a deep chesnut brown colour, with a yellowish cast on the abdomen. All the insects of this genus, in their various stages of transformation, prey on the smaller insects and worms; the larva and pupa are active, eight-footed, and resemble the perfect insect. To this genus belong to the well-known insects, called daddy long legs, shepherd or harvest spiders, which, notwithstanding their common name, differ very considerably from spiders properly so named. The most common insect of this kind, in England, is the P. opilio of Linnæus, which, during the autumn, may be observed in gardens, about walls, &c.: it is remarkable for its plump but flattish orbicular body, and its long and slender legs, which are generally so carried, that the body appears suspended or elevated to a considerable height above the surface on which the animal rests. P. cancroides: abdomen obovate, depressed, ferruginous chelæ, or claws, oblong, hairy. This species differs considerably in size. It inhabits Europe, and is said to be the little insect which gets into their legs, and under the skin, causing a painful itching.

PHALARIS, in botany, *canary grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx two-valved, keeled, the valves equal in length, inclosing the corolla. There are twelve species, of which P. canariensis, cultivated canary grass, has an annual root; the culm is from a foot to eighteen inches in height, upright, round, striated, swelling a little at the joints, at the lower ones frequently branching; leaves half an inch in breadth, of a lively green colour, the lower part of the leaf swells out like a spathe, completely involving, and protecting the head of flowers whilst young; this grass is a native of the canary islands; it is also found in a wild state in many parts of Britain. The cultivation of it is chiefly confined to the isle of Thanet, where it is esteemed a profitable crop.

PHALENA, in natural history, the *moth*, a genus of insects of the order Lepidoptera. Generic character: antennæ gradually tapering from the base to the tip; wings, when at rest generally deflected: flight nocturnal. They fly abroad only in the evening and during the night, and feed on the nectar of flowers: the larva is active and quick in motion, mostly smooth, more or less cylindrical, and preys on the leaves of various plants: pupa quiescent, more or less cylindrical; pointed at the tip, or at both ends, and is generally inclosed in a follicle. This genus contains a vast number of species, and is divided into assortments according to the different habits of the animals: these are,

1. Attaci, or those in which the wings, when at rest, are spread out horizontally.
2. Bombyces, in which the wings are incumbent and the antennæ pectinated.
3. Noctuæ, with incumbent wings setaceous antennæ.
4. Geometræ, with wings horizontally spread out, nearly as the attaci.
5. Tortrices, with very obtuse wings, curved on the exterior margin.
6. Pyralides, with wings converging into a deltoid, and slightly furcated figure.
7. Tineæ, with wings convoluted into a cylinder.
8. Alucitæ, with wings divided into distinct plumes.

Of all the European species of the first division, the finest, by much, is P. junonia, a native of many parts of Germany, Italy, France, &c. but not yet observed in England. It measures about six inches in extent of wings, and is varied by a most beautiful assortment of the steady colours. The caterpillar which feeds on the apple, pear, &c. is hardly less beautiful than the insect itself, and, when ready for its change, it envelopes itself in an oval web

with a pointed extremity, and transforms itself into a large short chrysalis, out of which emerges the moth. See Plate IV. Entomology, fig. 1.

P. peronia, minor Peacock moth, is a native of England, and is commonly called the emperor moth.

Of the bombyces we must notice the P. caja, or great tiger-moth, which is one of the largest English moths, and is of a fine cream colour, with chocolate-brown bars and spots; the lower wings red, with black spots; the thorax chocolate brown, with a red collar round the neck, and the body red, with black bars. The caterpillar is of a deep brown, with white specks, very hairy, and feeds on various plants.

P. vinula, of England, is remarkable for elegance of appearance without gaiety of colour, being a middle-sized white moth, variegated with numerous small black streaks and specks: the thorax and abdomen are extremely downy, and the body is marked by transverse black bars. The caterpillar of this moth is far more brilliant in its appearance than the complete animal; it is of considerable size, measuring above two inches in length, and is of a most beautiful green colour, with the back of a dull purple, freckled with very numerous deeper streaks in a longitudinal direction: this purple of the back is separated from the green on the sides by a pair of milk-white stripes, which, commencing from the head, run upwards to the top of the back; that part being eleveated considerably above the rest into a pointed process; and from thence are continued along the sides to the tail: the face is flat and subtriangular, yellowish, surrounded first by a black, and then by a red border; and is distinguished by two deep black eyes or spots on each side the upper part: from the tail, which is extended into two long, roughened, sharp-pointed, tubular processes, proceed on the least irritation, two long, red, flexible tentacula, the animal seeming to exert them as if for the purpose of terrifying its disturbers; lifting up the fore-part of the body at the same time, in a menacing attitude, and presenting a highly grotesque appearance: it also possesses the power of suddenly ejecting from its mouth, to a considerable distance, an acrimonious reddish fluid, which it uses as a further defence, and which produces considerable irritation, if it happens to be thrown into the eyes of the spectator. This caterpillar is principally seen on willows and poplars, and when the time of its change arrives, descends to the lower part of the tree, and envelopes itself in a glutinous case, prepared by moistening with its saliva the woody fibres of the tree, and covering itself with them, attaching the edges very closely to the bark: this case, having very much the colour of the bark itself, is not very conspicuous, so that the insect generally remains secure under its covering throughout the whole winter, it being too close to be penetrated by the frost, and too strong to be successfully attacked by birds, &c. it requires even a very sharp knife, assisted by a strong hand, to force it open. The chrysalis is thick, short, and black, and in the month of May or June, according to the warmth or coolness of the season, gives birth to the moth, which, immediately on emerging from the upper part of the chrysalis, discharges a quantity of fluid sufficient to soften effectually the walls of its prison, and effect a ready escape. This moth, from its unusually downy appearance, has obtained the popular title of the puss moth.

But of all the moths of the tribe Bombyx, the P. mori, or silk-worm moth, is by far the most important. This is a whitish moth, with a broad pale brown bar across each of the upper wings. The caterpillar or larva, emphatically known by the title of the silkworm, is, when full grown, nearly three inches long, and of a yellowish grey colour: on the upper part of the last joint of the body is a horn-like process, as in many of the sphinges. It feeds, as every one knows, on the leaves of the white mulberry, in defect of which may be substituted the black mulberry, and even, in some instances, the lettuce, and a few other plants. The silkworm remains in its larva state about six weeks, changing its skin four times during that period, and, like other caterpillars, abstaining from food for some time before each change. When full grown the animal entirely ceases to feed, and begins to form itself a loose envelopement of silken fibres, in some convenient spot which it has chosen for that purpose, and afterwards proceeds to enwrap itself in a much closer covering, forming an oval yellow silken case or ball about the size of a pigeon's egg, in which it changes to a chrysalis, and after lying thus inclosed for the space of about fifteen days, gives birth to the moth. This, however, is always carefully prevented when the animals are reared for the purpose of commerce, the moth greatly injuring the silk of the ball by discharging a quantity of coloured fluid before it leaves the cell; the silk balls are therefore exposed to such a degree of heat as to kill the inclosed chrysalides, a

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few only being saved for the breed of the following year. The moth, when hatched, is a very short-lived animal, breeding soon after its exclusion, and when the females have laid their eggs, they, as well as the males, survive but a very short time.

As an example of the Geometræ, we may adduce a very elegant moth, often seen towards the middle of summer, in Europe, on the elder, and called P. sambucaria; it is moderately large, of a pale sulphur colour, with angular wings, marked by a narrow transverse brown line or streak It proceeds from a green caterpillar, which, like those of the rest of this section, walks in a peculiar manner, *viz.* by raising up the body at each progressive movement into the form of an arch or loop, the extremities nearly approaching each other. It changes in May and June into a black chrysalis, out of which in June or July, proceeds the moth.

The division called Tineæ comprehends those moths which are, in general, of a small size, though often of very elegant colours. Of this tribe is the P. padella: it is of a pearly white colour, with very numerous black spots: its caterpillar is gregarious, appearing in great quantities on various sorts of fruit trees in Europe during the decline of summer, and committing great ravages on the leaves: these caterpillars inhabit a common web, and usually move in large groups together; their colour is a pale greyish yellow, with numerous black spots; each caterpillar at the time of its change to chrysalis, envelopes itself in a distinct oval web with pointed extremities, and many of these are stationed close to each other, hanging in a perpendicular direction from the internal roof of the general inclosing web: the chrysalis is blackish, and the moth appears in the month of September. To this division also belong the moths, emphatically so called, or cloth moths. Of these the principal is the P. vestianella, which in its caterpillar state, is very destructive to woollen cloths, the substance of which it devours, forming for itself a tubular case with open extremities, and generally approaching to the colour of the cloth on which it is nourished. This mischievous species changes into a chrysalis in April, and the moth, which is universally known, appears chiefly in May and June.

In the last division, called Alucitæ, is one of the most elegant of the insect tribe, though not distinguished either by large size or lively colours. It is a small moth, of a snowy whiteness, and, at first view, catches the attention of the observer by the very remarkable aspect of its wings, which are divided into the most beautiful distinct plumes, two in each upper, and three in each under wing, and formed on a plan resembling that of the long wing feathers of birds, *viz.* with a strong middle rib or shaft, and innumerable lateral fibres. This moth, which is the P. pentadactyle of Linnæus, an European species, appears chiefly in the month of August. Its caterpillar, which is yellowish green, speckled with black, feeding on nettles, and changing into a blackish chrysalis enveloped in a white web.

PHARMACY. This is a very important branch of therapeutic science, which in the article on MATERIA MEDICA we have observed, embraces the three divisions of medicinal materials, the preparation of those materials, and the diseases in which they are employed. Pharmacy includes the second of these divisions; and is, hence, the doctrine of preserving, arranging, compounding, and intermixing the different articles of the Materia Medica, so that as simple substances we may obtain their virtues in the most active or most convenient form, and in a state of combination, redouble or vary their powers, according to the intention we have in view. In prosecuting this object, a multiplicity of operations are necessary, some of them mechanical, some chemical, which constitute the means by which the result is to be attained; and under this natural division, the means and the end, pharmaceutical operations, and pharmaceutical preparations, we shall consider the subject before us.

PART I.

PHARMACEUTICAL OPERATIONS.

Under this head we shall comprise the mode of collecting and preserving medicinal simples; the mechanical instruments employed, and the changes they introduce; chemical instruments and apparatus, their use, application and power.

Collection and Preservation of Simples.

Each of the kingdoms of nature furnishes articles employed in medicine in their natural state, or when prepared by pharmacy; and in collecting these, our first attention should be to make choice of sound and perfect substances; to throw off whatever is injured or decayed, and

to separate them from all adventitious matters. As a general rule, they must be defended from the effects of moisture, great heat, cold, and freely exposed to the air. Yet when their activity and virtue depend on volatile principles, instead of being freely exposed to the air, they must be confined, as much as possible, from its contact.

The vegetable kingdom affords us the most numerous articles; these should rather be obtained from countries in which they grow naturally, than countries in which they merely grow by transplantation; and those which grow wild, in dry soils, and exposed situations, fully open to the air and the sun, are for the most part to be preferred to plants that are cultivated, or that grow in moist, low, shady, and confined situations. Annual roots should be collected before they shoot forth their stalks or flowers; biennial roots in the harvest of their first year, or the spring-time of their second; perennial roots either in the spring time before the sap has begun to mount, or in harvest after it has returned. Worm-eaten or decayed roots, except in a few cases of resinous plants, are to be rejected; the rest are to be cleaned immediately with a brush and cold water; immersing them in the water as short a time as possible, and cutting off the radicles and fibres when not essential. Roots which consist chiefly of fibres, and have but a small sap, may be dried at once; if juicy and not aromatic, in a heat somewhat below 100° of Fahrenheit; but if aromatic, by simply exposing them to a current of cold dry air, and frequently turning them in it. If very thick and strong, they must be split and cut into slices, and strung upon threads; if covered with a tough bark they may be peeled and dried while fresh. Such as lose their virtues by drying are to be kept buried in dry sand.

It is difficult to lay down general rules for collecting stalks and leaves, some of which acquire, while others lose their activity by age. Aromatics should be collected after the flower-buds are formed; non-aromatics, if annuals, when in flower, or about to flower; biennials before they shoot; and perennials before they flower, especially the woody-fibred. They should be gathered in dry weather, after the morning dew is off, or before it falls in the evening. Generally speaking, they should be tied in bundles, and hung up in a shady, warm, and airy place, or spread upon the floor, and frequently turned. If very juicy, they are to be laid upon a sieve, and dried by a gentle degree of artificial warmth. Sprouts are to be collected before the buds open; and stalks to be gathered in autumn. Barks are to be collected when the most active parts of the vegetable are concentrated in them. Spring is preferred for resinous barks, and autumn for the others which are rather gummy than resinous. Young trees afford the best bark for medical purposes.

The same rules apply to the collection of woods; but they must not be taken from very young trees. Among the resinous woods, the heaviest, which sink in water, are selected. The alburnum is to be rejected.

Flowers are collected in clear dry weather, before noon, but after the dew is off; either when they are just about to open, or immediately after they have opened. Of some the petals only are preserved, and the colourless claws are even cut away; of others, whose calyx is odorous, the whole flower is kept. Flowers which are too small to be pulled singly, are dried with part of the stalk: these are called heads or tops.

Flowers are to be dried nearly as leaves, but more quickly, and with more attention. As they must not be exposed to the sun, it is best done by a slight degree of artificial warmth. When they lose their colour and smell they are unfit for use.

Seeds and fruits, unless when otherwise directed, are to be gathered when ripe, but before they fall spontaneously. Some pulpy fruits are freed from their core and seeds, strung upon thread, and dried artificially. They are in general best preserved in their natural coverings, although some, as the colocynth, are peeled, and others, as the tamarind, preserved fresh. Many of these are apt to spoil, or become rancid; and as they are then no longer fit for medical use, no very large quantity of them should be collected at a time.

The proper drying of vegetable substances is of the greatest importance. It is often directed to be done in the shade, and slowly, that the volatile and active particles may not be dissipated by too great heat; but this is an error, for they always lose infinitely more by slow than by quick drying. When, on account of the colour, they cannot be exposed to the sun, and the warmth of the atmosphere is insufficient, they should be dried by an

artificial warmth, less than 100° Fahrenheit, and well exposed to a current of air. When perfectly dry and friable, they have little smell; but after being kept some time, they attract moisture from the air, and regain their proper odour.

The boxes and drawers in which vegetable matters are kept, should not impart to them any smell or taste; and more certainly to avoid this, they should be lined with paper. Such as are volatile, of a delicate texture, or subject to suffer from insects, must be kept in well covered glasses. Fruits and oily seeds, which are apt to become rancid, must be kept in a cool and dry, but by no means in a warm or moist place.

Oily seeds, odorous plants, and those containing volatile principles, must be collected fresh every year. Others, whose properties are more permanent, and not subject to decay, will keep for several years. Vegetables collected in a moist and rainy season are in general more watery and apt to spoil. In a dry season, on the contrary, they contain more oily and resinous particles, and preserve much better.

Mechanical Operations.

These consist of the mode of determining the weight or measure of bodies; their division into minute particles; their separation of part from part, or of the useful from the useless; the modes of intermixing them.

Weights and Measures. The quantities of substances employed as medicines are determined with the greatest accuracy by weighing. The scales should balance with the utmost precision, and turn with the utmost facility. Balances should be defended as much as possible from acid and other corrosive vapours, and not be unnecessarily suspended, as their delicacy of decision is hereby much impaired; and to guard against this last evil in another way, they should never be over-loaded.

The want of an uniformity of weights and measures, which is felt in every country, and in every branch of trade and commerce, is of peculiar inconvenience in pharmacy. All our college pharmacopoeias command the use of troy weight; yet the wholesale druggists in every instance, excepting where a very small portion of an article is bought by grains, scruples, or drachms, sell by avoirdupoise weight; and there is reason to fear that, both amongst apothecaries and druggists, most of the pharmaceutic compositions are prepared by this last division; in consequence of which it is impossible for the physician to know the exact strength of the dose he prescribes; and if he do, he cannot often obtain it in the proper proportions of its respective ingredients. The difficulty is still increased by a promiscuous use of weights and measures, in determining the quantities of fluids; on which account, though the London college still authorises both for distinct purposes, the colleges of Edinburgh and Dublin have rejected measures altogether.

For measuring fluids, the graduated glass measures are always to be preferred: they should be of different sizes, according to the quantities they are intended to measure. Elastic fluids are also measured in glass tubes, graduated by inches and their decimals.

Specific gravity is the weight of a determinate bulk of any body. For a standard of comparison distilled water has been assumed as unity. The specific gravity of solids is ascertained by comparing the weight of the body in the air with its weight when suspended in water. The quotient obtained by dividing its weight in air, by the difference between its weight in air and its weight in water, is its specific gravity. The specific gravity of fluids may be ascertained by comparing the loss of weight of a solid body, such as a piece of crystal, when immersed in distilled water, with its loss when immersed in the fluid we wish to examine; by dividing its loss of weight in the fluid by its loss of weight in the water, the quotient is the specific gravity of the fluid; or a small phial, containing a known weight of distilled water, may be filled with the fluid to be examined and weighed, and by dividing the weight of the fluid by the weight of the water, the specific gravity is ascertained.

Although these are the only general principles by which specific gravities are ascertained, yet as the result is always influenced by the state of the thermometer and barometer at the time of the experiments, and as the manipulation is a work of great nicety, various ingenious instruments have been contrived to render the process and calculation easy. Of all these, the gravimeter of Morveau seems to deserve the preference.

It would be of material consequence to science and the arts, if specific gravities were always indicated by the numerical term expressing their relation to the specific gravity of distilled water. This, however, is unfortunately not the case,

The excise officers in this country collect the duties paid by spirituous liquors, by estimating the proportion which they contain of a standard spirit, about 0.933 in specific gravity, which they call hydrometer proof, and they express the relation which spirits of a different strength have to the standard spirit, by saying that they are above or under hydrometer proof. Thus one in six, or one in seven, below hydrometer proof means that it is equal in strength to a mixture of six parts of proof spirit with one of water.

The only other mode of expressing specific gravities which it is necessary to notice is that of Baume's areometer, as it is often used in the writings of the French chemists, and is little understood in this country. For substances heavier than water he assumes the specific gravity of distilled water as zero, and graduates the stem of his instrument downwards, each degree being supposed by him to express the number of parts of muriate of soda contained in a given solution, which however is not at all the case. For substances lighter than water the tube is graduated upwards, and this zero is afforded by a solution of 10 of salt in 90 water.

Mechanical Division. By this process substances are reduced to a form better adapted for medical purposes; and by the increase of their surface their action is promoted, both as medical and chemical agents. It is performed by cutting, bruising, grinding, grating, rasping, filing, pulverization, trituration, and granulation, by means of machinery or of proper instruments.

Pulverization is the first of these operations that is commonly employed in the apothecary's shop. It is performed by means of pestles and mortars. The bottom of the mortars should be concave; and their sides should neither be so inclined, as not to allow the substances operated on to fall to the bottom between each stroke of the pestle, nor so perpendicular as to collect it too much together, and to retard the operation. The materials of which the pestles and mortars are formed should resist both the mechanical and chemical action of the substances for which they are used, Wood, iron, marble, siliceous stones, porcelain, and glass, are all employed: but copper, and metals containing copper, are to be avoided. They should be provided with covers, to prevent the finest and lightest parts from escaping, and to defend the operator from the effects of disagreeable or noxious substances. But these ends are more completely attained by tying a piece of pliable leather round the pestle and round the mouth of the mortar. It must be closely applied, and at the same time so large, as to permit the free motion of the pestle. In some instances it will be even necessary for the operator to cover his mouth and nostrils with a wet cloth, and to stand with his back to a current of air, that the very acrid particles which arise may be carried from him. The addition of a little water or spirit of wine, or of a few almonds, to very light and dry substances, will prevent their flying off. But almonds are apt to induce rancidity, and powders are always injured by the drying which is necessary when they have been moistened. Water must never be added to substances which absorb it, or are rendered cohesive by it.

All vegetable substances must be previously dried. Resins and gummy resins, which become soft in summer, must be powdered in very cold weather, and must be beaten gently, or they will be converted into a paste instead of being powdered. Wood, roots, barks, horn, bone, ivory, &c. must be previously cut, split, chipped, or rasped. Fibrous woods and roots should be finely shaved after their bark is removed, for otherwise their powders will be full of hair-like filaments, which can scarcely be separated. Some substances will even require to be moistened with mucilage of tragacanth, or of starch, and then dried before they can be powdered. Camphor may be conveniently powdered by the addition of a little spirit of wine, or almond oil. The emulsive seeds cannot be reduced to powder unless some dry powder be added to them. To aromatic oily substances sugar is the best addition. All impurities and inert parts having been previously separated, the operation must be continued and repeated upon vegetable substances till no residuum is left. The powders obtained at different times must then be intimately mixed together, so as to bring the whole to a state of perfect uniformity.

Very hard stony substances must be repeatedly heated to a red heat, and then suddenly quenched in cold water, until they become sufficiently friable. Some metals may be powdered hot in a heated iron mortar, or may be rendered brittle by alloying them with a little mercury.

Trituration is intended for the still more

minute division of bodies. It is performed in flat mortars of glass, agate, or other hard materials, by giving a rotatory motion to the pestle; or on a levigating stone, which is generally of porphyry, by means of a muller of the same substance. On large quantities it is performed by rollers of hard stone, turning horizontally upon each other, or by one vertical roller turning on a flat stone.

The substances subjected to this operation are generally previously powdered or ground.

Levigation differs from trituration only in the addition of water or spirit of wine to the powder operated upon, so as to form the whole mass into a kind of paste, which is rubbed until it be of sufficient smoothness or fineness. Earths and some metallic substances are levigated.

Granulation is employed for the mechanical division of some metals. It is performed, either by stirring the melted metal with an iron rod until it cools, or by pouring it into water, and stirring it continually as before, or by pouring it into a covered box, previously well rubbed with chalk, and shaking it until the metal cools, when the rolling motion will be converted into a rattling one. The adhering chalk is then to be washed away.

Mechanical Separation is obtained by sifting, elutriation, decantation, filtration, despumation, expression.

Sifting. From dry substances, which are reduced to the due degree of minuteness, the coarser particles are to be separated by sieves of iron-ware, hair-cloth, or gauze, or by being dusted through bags of fine linen. For very light and valuable powders, or acrid substances, compound sieves, having a close lid and receiver, must be used. The particles which are not of sufficient fineness to pass through the interstices of the sieve, may be again powdered.

Elutriation is confined to mineral substances, on which water has no action. It is performed by separating them from foreign particles and impurities, of a different specific gravity, in which case they are said to be washed; or for separating the impalpable powders, obtained by trituration and levigation from the coarser particles. This process depends upon the property that very fine or light powders have of remaining for some time suspended in water; and is performed by diffusing the powder or paste formed by levigation through plenty of water, letting it stand a sufficient time, until the coarser particles settle at the bottom; and then pouring off the liquid in which the finer or lighter particles are suspended. Fresh water may be poured on the residuum, and the operation repeated; or the coarser particles, which fall to the bottom, may be previously levigated a second time.

Decantation. The fine powder which is washed over with the water is separated from it, by allowing it to subside completely, and by either decanting off the water very carefully, or by drawing it off by a syringe or syphon. These processes are very frequently made use of for separating fluids from solids which are specifically heavier, especially when the quantity is very large, or the solid so subtle as to pass through the pores of most substances employed for filtration, or the liquid so acrid as to corrode them

Filtration. For the same purpose of separating fluids from solids, straining and filtration are often used. These differ only in degree, and are employed when the powder either does not subside at all, or too slowly and imperfectly for decantation. The instruments for this purpose are of various materials, and must in no instance be acted upon by the substances for which they are employed. Fats, resins, wax, and oils, are strained through hemp or flax, spread evenly over a piece of wire-cloth or net stretched in a frame. For saccharine and mucilaginous liquors, fine flannel may be used: for some saline solutions, linen. Where these are not fine enough, unsized paper is employed; but it is extremely apt to burst by hot watery liquors, which dissolve its size; and very acrid liquors, such as acids, are filtered by means of a glass-funnel, filled with powdered quartz, a few of the larger pieces being put into the neck, smaller pieces over these, and the finer powder placed over all. The porosity of this last filter retains much of the liquor; but it may be recovered by gently pouring on it as much distilled water; the liquor will then pass through, and the water be retained in its place.

Water may be filtered in large quantities through basins of porous stone, or artificial basins of nearly equal parts of fine clay and coarse sand. The size of the filters depends on the quantity of matter to be strained. When large, the flannel or linen is formed into a conical bag, and suspended from a hoop or frame; the paper is either spread on the inside of these bags, or folded into a conical form,

and suspended by a funnel. It is of advantage to introduce glass rods, or quill-barrels, between the paper and funnel, to prevent them from adhering too closely. What passes first is seldom fine enough, and must be poured back again, until, by the swelling of the fibres of the filter, or filling up of its pores, the fluid acquires the requisite degree of limpidity. The filter is sometimes covered with charcoal powder, which is a useful addition to muddy and deep-coloured liquors. The filtration of some viscid substances is much assisted by heat.

Expression is a species of filtration, assisted by mechanical force. It is principally employed to obtain the juices of fresh vegetables, and the unctuous vegetable oils. It is performed by means of a screw press with plates of wood, iron, or tin. The subject of the operation is previously beaten, ground, or bruised. It is then inclosed in a bag, which must not be too much filled, and introduced between the plates of the press. The bags should be of hair-cloth, or canvass inclosed in hair-cloth. Hempen and wooden bags are apt to give vegetable juices a disagreeable taste. The pressure should be gentle at first, and increased gradually. Vegetables intended for this operation should be perfectly fresh and freed from all impurities. In general they should be expressed as soon as they are bruised, for it disposes them to ferment; but subacid fruits give a larger quantity of juice and of finer quality, when they are allowed to stand some days in a wooden or earthen vessel after they are bruised. To some vegetables which are not juicy enough of themselves, the addition of a little water is necessary. Lemons and oranges must be peeled, as their skins contain a great deal of essential oil, which would mix with the juice. The oil itself may be obtained separately, by expression with the fingers against a plate of glass.

For unctuous seeds, iron plates are used; and it is customary not only to heat the plates, but to warm the bruised seeds in a kettle over the fire, after they have been sprinkled with some water, as by these means the product is increased, and the oil obtained is more limpid. But as their disposition to rancidity is increased by it, if possible, this practice should be laid aside, or confined to exposing the bruised seeds, inclosed in a bag, to the steam of hot water.

Despumation is generally practised on thick and clammy liquors, which contain much slimy and other impurities, not easily separable by filtration. The scum arises either by simply heating the liquor, or by clarifying it, which is done by mixing with the liquor, when cold, whites of eggs well beaten with a little water, which on being heated coagulates, and entangling the impurities of the liquor, rises with them to the surface, and may be easily removed by a perforated ladle; or the liquor may now be filtered with ease. Spirituous liquors are clarified by means of isinglass dissolved in water, or any albuminous fluid, such as milk, which coagulates by the action of alcohol without the assistance of heat. Some expressed juices, such as those of the antiscorbutic plants, are instantly clarified by the addition of vegetable acid, such as the juice of bitter oranges.

Fluids can only be separated from each other when they have no tendency to combine, and when they differ in specific gravity. The separation may be effected by skimming off the lighter fluid with a silver or glass spoon; or by drawing it off by a syringe or syphon; or by means of a glass separatory, which is an instrument having a projecting tube, terminating in a very slender point, through which the heavier fluid alone is permitted to run; or by means of the capillary attraction of a spongy woollen thread; for no fluid will enter a substance, whose pores are filled by another for which it has no attraction; and, lastly, upon the same principle, by means of a filter of unsized paper, previously soaked in one of the fluids, which in this way readily passes through it, while the other remains behind.

Mechanical mixture is performed by agitation, trituration, or kneading; but these will be best considered in treating of the forms in which medicines are exhibited.

Chemical Operations and Results.

Under this chapter we have to consider the apparatus employed, the changes produced, and the general analyses that ensue.

The apparatus consists of vessels, fuel, or heat; and the different modes by which such fuel or heat is applied, whether lamps, furnaces, &c.

The vessels must necessarily vary in their form and materials; upon the first of which it will be more convenient to enlarge, as we proceed to treat of the particular operations in which they are

employed. In choosing the materials for the construction of our vessels, the properties most generally required are a power of resisting chemical agents, transparency, compactness, strength, fixity, and infusibility, and an ability to sustain sudden variations of temperature without breaking.

Generally speaking, metals possess the four last properties in considerable perfection; but they are all opaque. Iron and copper are apt to be corroded by chemical agents; and a solution of the last is often followed by dangerous affections. Tinning them will sometimes, but not always, answer; for tin and lead are often too fusible. Platinum, gold, and silver, resist most of the chemical agents, but are too expensive for general use.

Good earthenware resists the greatest intensity of heat, but has no other property to recommend it. Clay, the basis of all such wares, is plastic when worked with water, and sufficiently hard when burnt with an intense heat. But intense heat contracts it unduly, and it is apt to split and crack upon exposure to sudden changes of temperature; whence it is necessary to counteract this property by the addition of some other substance. Siliceous sand, clay reduced to powder, and then burnt with a very intense heat, and plumbago, are occasionally used. These additions, however, are attended with other inconveniences; plumbago especially is liable to combustion, and sand diminishes the compactness; so that when not glazed they are porous, and when glazed they are acted upon by chemical agents. The chemical vessels manufactured by Messrs. Wedgewood are the best of this description, except porcelain, which is too expensive.

Glass possesses the three first qualities in an eminent degree, and may be heated red-hot without melting. Its greatest inconvenience is its disposition to crack or break in pieces when suddenly heated or cooled. As this is occasioned by its unequal expansion or contraction, it is best remedied by forming the vessels very thin, and giving them, in general, a rounded shape. Glass vessels should also be well annealed, that is, cooled very slowly, after being blown, by placing them immediately in an oven while they are yet in a soft state. When ill annealed, or cooled suddenly, glass is apt to fly in pieces on the slightest change of temperature, or touch of a sharp point. We may sometimes take advantage of this imperfection; for by means of a red-hot wire glass vessels may be cut into any shape. Where there is not a crack already in the glass, the point of the wire is applied near the edge, by which a crack is formed; and this is afterwards easily led in any direction we wish.

Reaumur's porcelain is also glass, which, by being surrounded with hot sand, is made to cool so slowly that it assumes a crystalline texture that destroys its transparency, but imparts to it every other quality desirable in chemical vessels. The coarser kinds of glass are commonly used in making it; but as there is no manufacture of this valuable substance, its employment is still very limited.

Lutes also form a necessary part of chemical apparatus. They are compositions of various substances, intended to close the joining of vessels, to coat glass vessels, and to line furnaces. Lutes of the first description are commonly employed to confine elastic vapours. They should, therefore, possess the following properties: viscidity, plasticity, compactness, the power of resisting acrid vapours, and certain degrees of heat. The viscidity of lutes depends on the presence either of unctuous or resinous substances, mucilaginous substances, or clay.

Lutes of the first kind possess viscidity, and resist acrid vapours in an eminent degree; but they are in general so fusible, that they cannot be employed when they are exposed even to very low degrees of heat, and they will not adhere to any substance that is at all moist. The following are a few of this kind that have been most frequently employed:

Eight parts of yellow wax melted with one of oil of turpentine, with or without the addition of resinous substances, according to the degree of pliability and consistence required. Lavoisier's lute.

Four parts of wax melted with two of varnish and one of olive oil. Saussure's lute.

Three parts of powdered clay worked up into a paste, with one of drying oil, or, what is better, amber varnish. The drying oil is prepared by boiling 22.5 parts of litharge in 16 of linseed oil, until it be dissolved. Fat lute.

Chalk and oil, or glaziers' putty, is well fitted for luting tubes permanently into glass vessels, for it becomes so hard that it cannot be easily removed.

Equal parts of litharge, quick-lime, and powdered clay, worked into a paste with

oil varnish, is sometimes used to daub over the cracks in glass vessels, so as to render them again fit for some purposes.

Melted pitch and brick dust.

Mucilaginous substances, such as flour, starch, gum, and glue mixed with water, with or without some powder, are sufficiently adhesive, are dried by moderate degrees of heat, and are easily removed after the operation, by moistening them with water. But a high temperature destroys them, and they do not resist corrosive vapours. Of these take the following forms:

Slips of bladder macerated in water, and applied with the inside next the vessels. They are apt, however, from their great contraction on drying, to break weak vessels.

One part of gum arabic with six or eight of chalk, formed into a paste with water.

Flour worked into a paste with powdered clay or chalk.

Almond or linseed meal formed into a paste with mucilage or water.

Quicklime in fine powder, hastily mixed with white of egg, and instantly applied, sets very quickly, but becomes so hard that it can scarcely be removed.

Slaked lime in fine powder, with glue, does not set so quickly as the former.

The cracks of glass vessels are sometimes mended by daubing them and a suitable piece of linen over with white of egg, strewing both over with finely powdered quick lime, and instantly applying the linen closely and evenly.

Earthy lutes resist very high temperatures, but they become so hard that they can scarcely be removed, and often harden so quickly after they are mixed up, that they must be applied immediately. Examples:

Quick-lime well incorporated with a sixth part of muriate of soda.

Burnt gypsum, made up with water.

One ounce of borax dissolved in a pound of boiling water, mixed with a sufficient quantity of powdered clay. Mr. Watts's fire lute.

One part of clay with four of sand formed into a paste with water. This is also used for coating glass vessels, in order to render them stronger, and capable of resisting violent degrees of heat. It is then made into a very thin mass, and applied in successive layers, taking care that each coat be perfectly dry before another be laid on.

The lutes for lining furnaces will be described when treating of furnaces.

The junctures of vessels which are to be luted to each other, must previously be accurately and firmly fitted, by introducing between them, when necessary, short bits of wood or cork, or, if the disproportion be very great, by means of a cork fitted to the one vessel, having a circular hole bored through it, through which the neck of the other vessel or tube passes. After being thus fitted, the lute is either applied very thin, by spreading it on slips of linen or paper, and securing it with thread, or, if it is a paste lute, it is formed into small cylinders, which are successively applied to the junctures, taking care that each piece be made to adhere firmly and perfectly close in every part, before another is put on. Lastly, the whole is secured by slips of linen or bladder. In many cases, to permit the escape of elastic vapours, a small hole is made through the lute with a pin, or the lute is perforated by a small quill, fitted with a stopper.

Heat and Fuel. As caloric is an agent of the most extensive utility in the chemical operations of pharmacy, it is necessary that we should be acquainted with the means of employing it in the most economical and efficient manner. The rays of the sun are used in the drying of many vegetable substances, and the only attentions necessary are to expose as large a surface as possible, and to turn them frequently, that every part may be dried alike. They are also sometimes used for promoting spontaneous evaporation.

The combustion of different substances is a much more powerful and certain source of heat. The substances employed for this purpose, are either fluid or solid. Alcohol, oil, tallow, wood, turf, coal, charcoal, and coke, are all occasionally employed. Alcohol, oil, and melted tallow, fluid inflammables, must be burnt on porous wicks. These act merely mechanically, by drawing up a portion of the fluid to be volatilized and inflamed. They are therefore burnt in lamps of various constructions. But although commonly used to produce light, they afford a very uniform, though not very high temperature: it may, however, be increased by increasing the number of the wicks, and their size. Alcohol produces a steady heat, no soot, and, if strong, leaves no residuum. Oil gives a higher temperature, but on a common wick produces much smoke and soot. These are diminished, and the light and heat increased, by making the surface of the flame bear a large proportion to the centre, which is best

done by a cylindrical wick, so contrived that the air has free access both to the outside and to the inside of the cylinder, as in Argand's lamp, invented by Mr. Boulton of Birmingham. In this way, oil may be made to produce a considerable temperature, of great uniformity, and without the inconvenience of smoke.

Wicks have the inconvenience of being charred by the high temperature to which they are subjected, and of becoming so clogged as to prevent the fluid from rising in them: they must then be trimmed, but this is seldomer necessary with alcohol and fine oils than with the coarser oils. Lamps are also improved by adding a chimney to them: it must admit the free access of air to the flame, and then it increases the current, confines the heat, and steadies the flame. The intensity of the temperature of flame may be increased astonishingly, by forcing a small current of hot air through it, as by the blow-pipe. Wood, turf, coal, charcoal, and coke, solid combustibles, are burnt in grates and furnaces. Wood has the advantage of kindling readily, but affords a very unsteady temperature, is inconvenient from its flame, smoke, and soot, and requires much attention. The heavy and dense woods give the greatest heat, burn longest, and leave a dense charcoal. Dry turf gives a steady heat, and does not require so much attention as wood; but it consumes fast, its smoke is copious and penetrating, and the empyreumatic smell which it imparts to every thing it comes in contact with, adheres with great obstinacy. The heavy turf of marshes is preferable to the light, superficial turf. Coal is the fuel most commonly used in this country: its heat is considerable, and sufficiently permanent, but it produces much flame and smoke. Charcoal, especially of the dense woods, is a very convenient and excellent fuel: it burns without flame or smoke, and gives a strong, uniform, and permanent heat, which may be easily regulated, especially when it is not in too large pieces, and is a little damp; but it is costly, and burns quickly. Coke, or charred coal, possesses similar properties to charcoal; it is less easily kindled, but is capable of producing a higher temperature, and burns more slowly.

When an open grate is used for chemical purposes, it should be provided with cranes, to support the vessels operated in, that they may not be overturned by the burning away of the fuel.

Furnaces. In all these, the principal objects are, to produce a sufficient degree of heat, with little consumption of fuel, and to be able to regulate the degree of heat. An unnecessary expenditure of fuel is prevented by forming the sides of the furnace of very imperfect conductors of caloric, and by constructing it so, that the subject operated on may be exposed to the full action of the fire. The degree of heat is regulated by the quantity of air which comes in contact with the burning fuel. The quantity of air is in the compound ratio of the size of the aperture through which it enters, and its velocity. The velocity is increased by mechanical means, as by bellows, or by increasing the height and width of the chimney. The size and form of furnaces, and the materials of which they are constructed, are various, according to the purposes for which they are intended.

The essential parts of a furnace are, a body for the fuel to burn in; a grate for it to burn upon; an ash-pit to admit air, and receive the ashes; a chimney for carrying off the smoke and vapours.

The ash-pit should be perfectly close, and furnished with a door and register-plate, to regulate the quantity of air admitted. The bars of the grate should be triangular, and placed with an angle pointed downwards, and not above half an inch distant. The grate should be fixed on the outside of the body. The body may be cylindrical or elliptical, and it must have apertures for introducing the fuel and the subjects of the operation, and for conveying away the smoke and vapours. When the combustion is supported by the current of air naturally excited by the burning of the fuel, it is called a wind-furnace; when it is accelerated by increasing the velocity of the current by bellows, it forms a blast-furnace; and when the body of the furnace is covered with a dome, which terminates in the chimney, it constitutes a reverberatory furnace.

Furnaces are either fixed, and built of fire-brick, or portable, and fabricated of plate-iron. When of iron, they must be lined with some badly conducting and refractory substance, both to prevent the dissipation of heat, and to defend the iron against the action of the fire. A mixture of scales of iron and powdered tiles, worked up with blood, hair, and clay, is much recommended; and Professor Hagen says, that it is less apt to split and crack when exposed at once to a violent heat, than when dried gradually, according to the common directions. Dr

Black employed two different coatings. Next to the iron he applied a composition of three parts by weight of charcoal, and one of fine clay. These are first mixed in the state of fine powder, and then worked up with as much water as will permit the mass to be formed into balls, which are applied to the sides of the furnace, and beat very firm and compact, with the face of a broad hammer, to the thickness of about one inch and a half in general, but so as to give an elliptical form to the cavity. Over this, another lute, composed of six or seven parts of sand, and one of clay, is to be applied in the same manner, to the thickness of about half an inch. These lutes must be allowed to become perfectly dry before the furnace is heated, which should at first be done gradually. They may also be lined with fire-bricks of a proper form, accurately fitted and well cemented together before the top plate is screwed on.

The general fault of furnaces is, that they admit too much air, which prevents us from regulating the temperature. It either becomes too violent and unmanageable, or when more cold air is admitted than what is necessary for supporting the combustion, it carries off heat, and prevents us from raising the temperature as high as we otherwise would. The superior merit of Dr. Black's furnace consists in the facility with which the admission of air is regulated; and every attempt hitherto made to improve it, by increasing the number of its apertures, have in reality injured it.

Heat may be applied to vessels employed in chemical operations, directly, as in the open fire and reverberatory furnace: or through the medium of sand; the sand-bath: of water; the water-bath: of steam; the vapour-bath: of air; as in the muffle.

Changes produced by chemical processes. These consist chiefly in a new mode of aggregation, combination, and decomposition.

The form of *aggregation* may be altered by fusion, vaporization, condensation, congelation, and coagulation.

Fusion is the conversion of a solid into a liquid by the sole agency of caloric. Substances differ very much in the degrees of their fusibility; some, as water and mercury, existing as fluids in the ordinary temperatures of the atmosphere; while others, as the pure earths, cannot be melted by any heat we can produce.

Liquefaction is commonly employed to express the melting of substances, as tallow, wax, resin, &c. which pass through intermediate states of softness before they become fluid. Fusion is the melting of substances which pass immediately from the solid to the fluid state, as the salts and metals, except iron and platinum.

When, in consequence of fusion, the substances operated on acquire a greater or less degree of transparency, a dense uniform texture, and great brittleness, and exhibit a conchoidal fracture, with a specular surface, and the edges of the fragments very sharp, it is termed vitrifaction.

In general, simple substances are less fusible than compounds; for example, the simple earths cannot be melted singly, but when mixed are easily fused. The additions which are sometimes made to refractory substances, to promote their fusion, are termed fluxes: which fluxes are generally saline bodies.

Thus, the alkalies potash and soda promote powerfully the fusion of silicious stones; but they are only used for accurate experiments. The white flux is a mixture of a little potash with carbonate of potash, and is prepared by deflagrating together equal parts of nitrate of potash and super-tartrate of potash. When an oxide is at the same time to be reduced, the black flux is preferred, which is produced by the deflagration of two parts of super-tartrate of potash, and one of nitrate of potash. It differs from the former only in containing a little charcoal. Soap promotes fusion by being converted by the fire into carbonate of soda and charcoal.

Aluminous stones have their fusion greatly promoted by the addition of subborate of soda.

Muriate of soda, the mixed phosphate of soda and ammonia, and other salts, are also occasionally employed for the same purpose.

An open fire is sufficient to melt some substances, others require the heat of a furnace.

The vessels in which fusion is performed, must resist the heat necessary for the operation. In some instances an iron or copper ladle or pot may be used, but most commonly crucibles are employed. These are of various sizes. The large crucibles are generally conical, with a small spout for the convenience of pouring out; the small ones are truncated triangular pyramids, and are commonly sold

in nests. The Hessian crucibles are composed of clay and sand, and when good, will support an intense heat for many hours, without softening or melting; but they are disposed to crack when suddenly heated or cooled. This inconvenience may be on many occasions avoided, by using a double crucible, and filling up the interstice with sand, or by covering the crucible with a lute of clay and sand, by which means the heat is transmitted more gradually and equally. Those which ring clearly when struck, and are of an uniform thickness, and have a reddish brown colour, without black spots, are reckoned the best. Wedgewood's crucibles are made of clay mixed with baked clay finely pounded, and are in every respect superior to the Hessian, but they are very expensive. The black lead crucibles, formed of clay and plumbago, are very durable, resist sudden changes of temperature, and may be repeatedly used, but they are destroyed when saline substances are melted in them, and suffer combustion when exposed red hot to a current of air.

When placed in a furnace, crucibles should never be set upon the bars of the grate, but always upon a support. Dr. Kennedy found the hottest part of a furnace to be about an inch above the grate. They may be covered, to prevent the fuel or ashes from falling into them, with a lid of the same materials, or with another crucible inverted over them. When the fusion is completed, the substance may be either permitted to cool in the crucible, or may be poured into a heated mould anointed with tallow, never with oil, or what is still better, covered with a thin coating of chalk, which is applied by laying it over with a mixture of chalk diffused in water, and then evaporating the water completely by heat. To prevent the crucible from being broken by cooling too rapidly, it is to be either replaced in the furnace, to cool gradually with it, or covered with some vessel to prevent its being exposed immediately to the air.

Fusion is performed with the intention of weakening the attraction of aggregation; or of separating substances of different degrees of fusibility from each other.

Vaporization is the conversion of a solid or fluid into vapour by the agency of caloric. Although vaporability be merely a relative term, substances are said to be permanently elastic, volatile or fixed. The permanently elastic fluids or gases are those which cannot be condensed into a fluid or solid form by any abstraction of caloric we are capable of producing. Fixed substances, on the contrary, are those which cannot be converted into vapour by great increase of temperature. The pressure of the atmosphere has very considerable effect in varying the degree at which substances are converted into vapour. Some solids, unless subjected to very great pressure, are at once converted into vapour, although most of them pass through the intermediate state of fluidity.

Vaporization is employed to separate substances differing in volatility; and to promote chemical action, by disaggregating them.

When employed with either of these views, no regard is paid to the substances volatilized, whether from solids, as in ustulation and charring; or from fluids, as in evaporation; or whether the substances vaporized are condensed in proper vessels: for example, in a liquid form, as in distillation; or in a solid form, as in sublimation. Or whether the substances vaporized are permanently elastic, and are collected in their gaseous form, in a pneumatic apparatus.

Ustulation is almost entirely a metallurgic operation, and is employed to expel the sulphur and arsenic contained in some metallic ores. It is performed on small quantities in tests placed within a muffle. Tests are shallow vessels made of bone ashes or baked clay. Muffles are vessels of baked clay, of a semicylindrical form, the flat side forming the floor, and the arched portion the roof and sides. The end and sides are perforated with holes for the free transmission of air, and the open extremity is placed at the door of the furnace, for the inspection and manipulation of the process. The reverberatory furnace is commonly employed for roasting, and the heat is at first very gentle, and slowly raised to redness. It is accelerated by exposing as large a surface of the substance to be roasted as possible, and by stirring it frequently, so as to prevent any agglutination, and to bring every part in succession to the surface.

Charring may be performed on any of the compound oxides, by subjecting them to a degree of heat sufficient to expel all their hydrogen, nitrogen, and superabundant oxygen, while the carbon, being a fixed principle, remains behind in the state of charcoal. The temperature necessary for the operation may be pro-

duced either by the combustion of other substances, or by the partial combustion of the substance to be charred. In the former case, the operation may be performed in any vessel which excludes the access of air, while it permits the escape of the vapours formed. In the latter, the access of air must be regulated in such a manner, that it may be suppressed whenever the combustion has reached the requisite degree; for if continued to be admitted, the charcoal itself would be dissipated in the form of carbonic acid gas, and nothing would remain but the alkaline and earthy matter, which these substances always contain. When combustion is carried this length, the process is termed incineration. The vapours which arise in the operation of charring, are sometimes condensed, as in the manufacture of tar.

Evaporation is the conversion of a fluid into vapour, by its combination with caloric. In this process, the atmosphere is not a necessary agent, but rather a hindrance, by its pressure. This forms a criterion between chemical evaporation and spontaneous evaporation, which is merely the solution of a fluid in air. It is performed in open, shallow, or hemispherical vessels of silver, tinned copper or iron, earthenware or glass. The necessary caloric may be furnished by means of an open fire, a lamp, or a furnace, either immediately, or with the intervention of sand, water, or vapour. The degree of heat must be regulated by the nature of the substance operated on. In general, it should not be greater than what is absolutely necessary.

Evaporation may be partial; producing, from saline fluids, concentration; and from viscid fluids, inspissation; or it may be total, and produce exsiccation. Concentration is employed to lessen the quantity of diluting fluids, which is called dephlegmation; or as a preliminary step to crystallization. Inspissation is almost confined to animal and vegetable substances; and as these are apt to be partially decomposed by heat, or to become empyreumatic, it should always be performed, especially towards the end of the process, in a water or vapour bath. Exsiccation is here taken in a very limited sense; for the term is also with propriety used to express the drying of vegetables by a gentle heat, the efflorescence of salts, and the abstraction of moisture from mixtures of insoluble powders with water, by means of chalk-stones, or powdered chalk pressed into a smooth mass. At present, we limit its meaning to the total expulsion of moisture from any body by means of caloric. The exsiccation of compound oxides should always be performed in the water bath. Salts are deprived of their water of crystallization by exposing them to the action of heat in a glass vessel or iron ladle. Sometimes they first dissolve in their water of crystallization, or undergo what is called the watery fusion, and are afterwards converted into a dry mass by its total expulsion; as in the calcination of borax or burning of alum. When exsiccation is attended with a crackling noise, and splitting of the salt, as in muriate of soda, it is termed decrepitation, and is performed by throwing into a heated iron vessel small quantities of the salt at a time, covering it up, and waiting until the decrepitation be over, before a fresh quantity is thrown in. Exsiccation is performed on saline bodies, to render them more acrid or pulverulent, or to prepare them for chemical operations. Animal and vegetable substances are exsiccated, to give them a solid form, and to prevent their fermentation.

Condensation is the reverse of expansion, and is produced either by mechanical pressure forcing out the caloric in a sensible form, as water is squeezed out of a sponge, or by the chemical abstraction of caloric, which is followed by an approximation of the particles of the substance. This latter kind alone is the object of our investigation at present. In this way we may be supposed to condense substances existing naturally as gases or vapours; or substances, naturally solid or fluid, converted into vapours by adventitious circumstances. The former instance is almost supposititious; for we are not able, by any diminution of temperature, to reduce the permanently elastic fluids to a fluid or solid state. The latter instance is always preceded by vaporization, and comprehends those operations in which the substances vaporized are condensed in proper vessels.

When the product is a fluid, it is termed distillation; when solid, sublimation. Distillation is said to be performed, *viâ humidâ*, when fluids are the subjects of the operation. *Viâ siccâ*, when solids are subjected to the operation, and the fluid product arises from decomposition, and a new arrangement of the constituent principles. The objects of distillation are, to separate more volatile fluids from less volatile fluids or solids: to promote the

union of different substances: and to generate new products by the action of fire.

In all distillations, the heat applied should not be greater than what is necessary for the formation of the vapour, and even to this degree it should be gradually raised. The vessels also in which the distillation is performed should never be filled above one-half, and sometimes not above one-fourth, lest the substance contained in them should boil over.

As distillation is a combination of evaporation and condensation, the apparatus consists of two principal parts: the vessels in which the vapours are formed; and those in which they are condensed. The vessels employed for both purposes are very various in their shapes, according to the manner in which the operation is conducted. The first difference depends on the direction of the vapour after its formation. It either descends, ascends, or passes off by the side, constituting a distillation *per descensum, per ascensum*, or *per latus*.

In the distillation *per descensum*, a perforated plate of tinned iron, or other materials, is fixed within any convenient vessel, so as to leave a space beneath it. On this the subject of the operation is laid, and over it is placed another plate, accurately closing the mouth of the vessel, and sufficiently strong to support the fuel: thus the heat is applied from above, and the vapour is forced to descend into the inferior cavity, where it is condensed. In this way the oil of cloves is prepared, and on the same principles tar is manufactured, and mercury and zinc are separated from their ores.

In the distillation *per ascensum*, the vapour is allowed to rise to some height, and then is conveyed away to be condensed. The vessel most commonly employed for this purpose is the common copper still, which consists of a body for containing the materials, and a head into which the vapour ascends. From the middle of the head a tube rises for a short way, and is then reflected downwards, through which the steam passes to be condensed. Another kind of head, rising to a great height before it is reflected, is sometimes used for separating fluids, which differ little in volatility, as it was supposed that the less volatile vapours would be condensed and fall back into the still, while only the more volatile vapours would arise to the top, so as to pass to the refrigeratory. The same object may be more conveniently attained by managing the fire with caution and address. The greater the surface exposed, and the less the height the vapours have to ascend, the more rapidly does the distillation proceed; and so well are these principles understood by the Scotch distillers, that they do not take more than three minutes to discharge a still containing gallons of fluid.

The condensing apparatus used with the common still is very simple. The tube in which the head terminates is inserted into the upper end of a pipe, which is kept cool by passing through a vessel filled with water, called the refrigeratory. This pipe is commonly made of a serpentine form; but as this renders it difficult to be cleaned, Dr. Black recommends a sigmoid pipe. The refrigeratory may be furnished with a stop-cock, that when the water it contains becomes too hot, and does not condense all the vapour produced, it may be changed for cold water. From the lower end of the pipe, the product of the distillation drops into the vessel destined to receive it; and we may observe, that when any vapour issues along with it, we should either diminish the power of the fire, or change the water in the refrigeratory. There was a process of this kind, called circulation. It consisted in arranging the apparatus, so that the vapours were no sooner condensed into a fluid form, than this fluid returned back into the distilling vessels, to be again vaporised; and was effected by distilling in a glass vessel, with so long a neck that the vapours were condensed before they escaped at the upper extremity, or by inverting one matrass within another. When corrosive substances are distilled in this way, the cucurbit and alembic are used; but these substances are more conveniently distilled *per latus*.

The distillation *per latus* is performed in a retort, or pear-shaped vessel, having the neck bent to one side. The body of a good retort is well rounded, uniform in its appearance, and of an equal thickness, and the neck is sufficiently bent to allow the vapours, when condensed, to run freely away, but not so much as to render the application of the receiver inconvenient, or to bring it too near the furnace. The passage from the body into the neck must be perfectly free and sufficiently wide, otherwise the vapours produced in the retort only circulate in its body without passing over into the receiver. For introducing liquors into the retort without soiling its neck, which

would injure the product, a bent funnel is necessary. It must be sufficiently long to introduce the liquor directly into the body of the retort; and in withdrawing it, we must carefully keep it applied to the upper part of the retort, that the drop hanging from it may not touch the inside of the neck. In some cases, where a mixture of different substances is to be distilled, it is convenient and necessary to have the whole apparatus properly adjusted before the mixture is made, and we must therefore employ a tubulated retort, or a retort furnished with an aperture, accurately closed with a ground stopper. This tubulature should be placed on the upper convex part of the retort before it bends to form the neck, so that a fluid poured through it may fall directly into the body without soiling the neck.

Retorts are made of various materials. Flint-glass is commonly used when the heat is not so great as to melt it. For distillations which require excessive degrees of heat, retorts, of earthenware, or coated glass retorts are employed. Quicksilver is distilled in iron retorts.

The simplest condensing apparatus used with the retort is the common glass receiver; which is a vessel of a conical or globular form, having a neck sufficiently wide to admit of the neck of the retort being introduced within it. To prevent the loss and dissipation of the vapours to be condensed, the retort and receiver may be accurately ground to each other, or secured by some proper lute. To prevent the receiver from being heated by the caloric evolved during the condensation of vapours in it, we must employ some means to keep it cool. It is either immersed in cold water, or covered with snow, or pounded ice, or a constant evaporation is supported from its surface, by covering it with a cloth, which is kept moist by means of the descent of water, from a vessel placed above it, through minute syphons or spongy worsted threads. But as, during the process of distillation, permanently elastic fluids are often produced, which would endanger the breaking of the vessels, these are permitted to escape either through a tubulature, or hole, in the side of the receiver, or rather through a hole made in the luting. Receivers having a spot issuing from their side, are used when we wish to keep separate the products obtained at different periods of any distillation. For condensing very volatile vapours, a series of receivers, communicating with each other, termed adopters, were formerly used; but these are now entirely superseded by Woulfe's apparatus, which consists of a tubulated retort, adapted to a tubulated receiver. With the tubulature of the receiver, a three-necked bottle is connected by means of a bent tube, the further extremity of which is immersed, one or more inches, in some fluid contained in the bottle. A series of two or three similar bottles are connected with this first bottle in the same way. In the middle tubulature of each bottle a glass tube is fixed, having its lower extremity immersed about a quarter of an inch in the fluid. The height of the tube above the surface of the fluid must be greater than the sum of the columns of fluid standing over the further extremities of the connecting tubes, in all the bottles or vessels more remote from the retort. Tubes so adjusted are termed tubes of safety, for they prevent that reflux of fluid from the more remote into the nearer bottles, and into the receiver itself, which would otherwise inevitably happen on any condensation of vapour taking place in the retort, receiver, or nearer bottles. Different contrivances for the same purpose have been described by Messrs. Welter and Burkitt; and a very ingenious mode of connecting the vessels without lute has been invented by Citizen Girard, but they would not be easily understood without plates. The further tubulature of the last bottle is commonly connected with a pneumatic apparatus, by means of a bent tube. When the whole is properly adjusted, air blown into the retort should pass through the receiver, rise in bubbles through the fluids contained in each of the bottles, and at last escape by the bent tube. In the receiver, those products of distillation are collected which are condensable by cold alone. The first bottle is commonly filled with water, and the others with alkaline solutions, or other active fluids; and as the permanently elastic fluids produced are successively subjected to the action of all these, only those gases will escape by the bent tube which are not absorbable by any of them.

In separating permanently elastic fluids or gases from the substances in which they are found, we are compelled to employ a distinct pneumatic apparatus; and the gas may then be received either into vessels absolutely empty, or filled with some fluid, on which it exerts no action.

The first mode of collecting gases may be practised by means of a bladder, moistened sufficiently to make it perfectly

pliable, and then compressed so as to press out every particle of air from its cavity. In this state it may be easily filled with any gas. An oiled silk bag will answer the same purpose, and is more convenient in some respects, as it may be made of any size or form. Glass or metallic vessels, such as balloons, may also be emptied for the purpose of receiving gases, by fitting them with a stop-cock, and exhausting the air from them by means of an air-pump.

But the second mode of collecting gases is the most convenient and common. In which case the vessels may be filled either with a fluid lighter, or heavier, than the gas to be received into it.

The former method is seldom employed; but if we conduct a stream of any gas heavier than atmospheric air, such as carbonic acid gas, muriatic acid gas, &c. to the bottom of any vessel, it will gradually displace the air, and fill the vessel. On the contrary, a gas lighter than atmospheric air, such as hydrogen, may be collected in an inverted vessel by conducting a stream of it to the top. But gases are most commonly collected by conducting the stream of gas into an inverted glass-jar, or any other vessel filled with water or mercury. The gas ascends to the upper part of the vessel, and displaces the fluid. In this way gas may be kept a very long time, provided a small quantity of the fluid be left in the vessels, which prevents both the escape of the gas, and the admission of atmospheric air.

The vessels may be made of various shapes; but those most commonly employed are cylindrical. They may be either open only at one extremity, or furnished at the other with a stop-cock. The manner of filling them with fluid, is to immerse them completely in it, with the open extremity directed a little upwards, so that the whole air may escape from them, and then inverting them with their mouths downwards. For filling them with convenience, a trough or cistern is commonly used. This should either be hollowed out of a solid block of wood or marble; or, if it be constructed of wood simply, be well painted or lined with lead or tinned copper. Its size may vary very much; but it must contain a sufficient depth of fluid to cover the largest transverse diameter of the vessels to be filled in it. At one end or side, there should be a shelf for holding the vessels after they are filled. This shelf should be placed about an inch and a half below the surface of the fluid, and should be perforated with several holes, forming the apices of corresponding conical excavations on the lower side, through which, as through inverted funnels, gaseous fluids may be more easily introduced into the vessels placed over them. In general the vessels used with a mercurial apparatus should be stronger and smaller than those for a water cistern, and we must have a variety of glass and elastic tubes, for conveying the gases from the vessels in which they are formed to the funnels under the shelf.

The repeated distillation of any fluid is denominated rectification. When distillation renders the fluid stronger, or abstracts water from it, it is termed dephlegmation. When a fluid is distilled off from any substance, it is called abstraction; and if the product be redistilled from the same substance, or a fresh quantity of the same substance, it is denominated cohobation.

The difference between distillation and sublimation is only in the form of the product. When it is compact, it is termed a sublimate; when loose and spongy, it formerly had the appellation of flowers. Sublimation is sometimes performed in a crucible, and the vapours are condensed in a paper cone, or in another crucible inverted over it; sometimes in the lower part of a glass flask, cucurbit, or phial, and the condensation is effected in the upper part or capital, and sometimes in a retort with a very short and wide neck, to which a conical receiver is fitted. The heat is most commonly applied through the medium of a sand-bath; and the degree of heat, and the depth to which the vessel is inserted in it, are regulated by the nature of the sublimation.

Congelation is the reduction of a fluid to a solid form, in consequence of the abstraction of caloric. The means employed for abstracting the caloric, are the evaporation of volatile fluids, the solution of solids, and the contact of cold bodies.

Coagulation is the conversion of a fluid into a solid of greater or less consistence, merely in consequence of a new arrangement of its particles, as during the process there is no separation of caloric or any other substance. The means of producing coagulation are, increase of temperature, and the addition of certain substances, as acids and rennets.

Chemical Combination, is the intimate union of the particles of at least two heterogeneous bodies. It is the effect resulting from the exertion of the attraction

of affinity, and is therefore subjected to all the laws of affinity.

To produce the chemical union of any two or more bodies, it is necessary, that they possess an affinity for each other; that their particles come into actual contact; that the strength of the affinity be greater than any counteracting causes which may be present.

The principal counteracting causes are, the attraction of aggregation; and affinities for other substances. The means to be employed for overcoming the action of other affinities, will be treated of under Decomposition. The attraction of aggregation is overcome by means of mechanical division; or the action of caloric.

Combination is facilitated by increasing the points of actual contact, by the means of mechanical agitation; by condensation and compression; and the processes employed for producing combination may be considered, with regard to the nature of the substances combined, and to the nature of the compound produced. Gases combine with gases, and dissolve fluids or solids, or are absorbed by them. Fluids are dissolved in gases, or absorb them: they combine with fluids, and dissolve solids, or are rendered solid by them. Solids are dissolved in fluids and in gases, or absorb gases, and solidify fluids.

The combination of gases with each other, in some instances, takes place when simply mixed together: thus nitrous and oxygen gases combine as soon as they come into contact; in other instances, it is necessary to elevate their temperature to a degree sufficient for their inflammation, either by means of the electric spark, or the contact of an ignited body, as in the combination of oxygen gas with hydrogen or nitrogen gas.

When gases combine with each other there is always a considerable diminution of bulk, and not unfrequently they are condensed into a liquid or solid form. Hydrogen and oxygen gases form water; muriatic acid and ammonia gases form solid muriate of ammonia. But when the combination is effected by ignition, a violent expansion, which endangers the bursting of the vessels, previously takes place, in consequence of the increase of temperature.

Solution is the diminution of aggregation in any solid or fluid substance, in consequence of its entering into chemical combination. The substance, whether solid or fluid, whose aggregation is lessened, is termed the solvend; and the substance, by whose agency the solution is effected, is often called the menstruum or solvent. Solution is said to be performed *viâ humidâ*, when the natural form of the solvent is fluid; but when the agency of heat is necessary to give the solvent its fluid form, the solution is said to be performed *viâ siccâ*. The dissolving power of each menstruum is limited, and is determinate with regard to each solvend. The solubility of bodies is also limited and determinate with regard to each menstruum.

When any menstruum has dissolved the greatest possible quantity of any solvend, it is said to be saturated with it. But, in some cases, although saturated with one substance, it is still capable of dissolving others. Thus a saturated solution of muriate of soda will dissolve a certain quantity of nitrate of potash, and after that, a portion of muriate of ammonia.

The dissolving power of solvents, and consequently the solubility of solvends, are generally increased by increase of temperature: and conversely, this power is diminished by diminution of temperature; so that from a saturated solution, a separation of a portion of the solvend generally takes place on any reduction of temperature. This property becomes extremely useful in many chemical operations, especially in crystallization.

Particular terms have been applied to particular cases of solution.

The solution of a fluid in the atmosphere is termed spontaneous evaporation. It is promoted by exposing a large surface, by frequently renewing the air in contact with the surface, and by increase of temperature.

Some solids have so strong an affinity for water, that they attract it from the atmosphere in sufficient quantity to dissolve them; these are said to deliquesce; others, on the contrary, retain their water of crystallization with so weak a force, that the atmosphere attracts it from them, so that they crumble into powder. These are said to effloresce. Both operations are promoted by exposing large surfaces, and by a current of air; but the latter is facilitated by a warm, dry air, and the former by a cold, humid atmosphere.

Solution is also employed to separate substances, (for example, saline bodies), which are soluble in the menstruum, from others which are not. When our

object is to obtain the soluble substance in a state of purity, the operation is termed lixiviation, and as small a quantity of the menstruum as is possible is used. When, however, it is employed to free an insoluble substance from soluble impurities, it is termed edulcoration, which is best performed by using a very large quantity of the menstruum.

Organic products being generally composed of heterogeneous substances, are only partially soluble in the different menstrua. To the solution of any of these substances, while the others remain undissolved, the term extraction is applied; and when, by evaporation, the substance extracted is reduced to a solid form, it is termed an extract, which is hard or soft, watery or spiritous, according to the degree of consistency it acquires, and the nature of the menstruum employed.

Infusion is employed to extract the virtues of aromatic and volatile substances, which would be dissipated by decoction, and destroyed by maceration, and to separate substances of easy solution from others which are less soluble. The process consists in pouring upon the substance to be infused, placed in a proper vessel, the menstruum, either hot or cold, according to the direction, covering it up, agitating it frequently, and, after a due time, straining or decanting off the liquor, which is now termed the infusion.

Maceration differs from infusion, in being continued for a longer time, and can only be employed for substances which do not easily ferment or spoil.

Digestion, on the other hand, differs from maceration only in the activity of the menstruum being promoted by a gentle degree of heat. It is commonly performed in a glass matrass, which should only be filled one-third, and covered with a piece of wet bladder, pierced with one or more small holes, so that the evaporation of the menstruum may be prevented as much as possible, without risk of bursting the vessel. The vessel may be heated, either by means of the sun's rays, of a common fire, or of the sand-bath : and when the last is employed, the vessel should not be sunk deeper in the sand than the portion that is filled. Sometimes when the menstruum employed is valuable, a distilling apparatus is used to prevent any waste of it. At other times, a blind capital is luted on the matrass, or a smaller matrass is inverted within a larger one; and as the vapour which arises is condensed in it, and runs back into the larger, the process in this form has got the name of circulation, upon which we have observed already.

Decoction is performed by subjecting the substances operated on, to a degree of heat which is sufficient to convert the menstruum into vapour, and can only be employed with advantage for extracting principles which are not volatile, and from substances whose texture is so dense and compact as to resist the less active methods of solution. When the menstruum is valuable, that portion of it which is converted into vapour is generally saved by condensing it in a distilling apparatus.

Solutions in alcohol, if coloured, are termed tinctures, and in vinegar or wine, medicated vinegars or wines. The solution of metals in mercury is termed amalgamation. The combinations of other metals with each other form alloys.

Absorption is the condensation of a gas into a fluid or solid form, in consequence of its combination with a fluid or solid. It is facilitated by increase of surface and agitation; and the power of absorption in fluids is much increased by compression and diminution of temperature, although in every instance it be limited and determinate. Dr. Nooth invented an ingenious apparatus for combining gases with fluids, and Messrs. Schweppe, Paul, and Cuthbertson have very advantageously employed compression.

Fluids often become solid by entering into combination with solids, and this change is always accompanied by considerable increase of temperature, as in the slaking of lime.

Chemical Decomposition is the separation of the elementary parts of bodies which were chemically combined: and can only be effected by the agency of substances possessing a stronger affinity for one or more of the constituents of the compound, than these possess for each other.

Decomposition has acquired various appellations, according to the phenomena which accompany it.

Dissolution differs from solution in being accompanied by a decomposition, or change in the nature of the substance dissolved. Thus, we correctly say, a solution of lime in muriatic acid, and a dissolution of chalk in muriatic acid.

Sometimes a gas is separated during the action of bodies on each other. When this escapes with considerable violence and agitation of the fluid it is termed ef-

fervescence. The gas is very frequently allowed to escape into the atmosphere, but at other times is either collected in a pneumatic apparatus, or made to enter into some new combination. The vessels in which an effervescing mixture is made, should be high and sufficiently large, to prevent any loss of the materials from their running over, and in some cases the mixture must be made slowly and gradually.

Precipitation is the reverse of solution. It comprehends all those processes in which a solid is obtained by the decomposition of a solution. The substance separated is termed a precipitate, if it sink to the bottom of the fluid; or a cream, if it swim above it. Precipitation, like solution, is performed either *viâ humidâ*, or *viâ siccâ*; and is effected by lessening the quantity of the solvent by evaporation; by diminishing its powers, as by reduction of temperature, or dilution; or by the addition of some chemical agent, which, from its more powerful affinities, either combines with the solvent, and precipitates the solvend, or forms itself an insoluble compound with some constituent of the solution.

The objects of precipitation are, the separation of substances from solutions in which they are contained; the purification of solutions from precipitable impurities; or the formation of new combinations.

The two first means of precipitation have been already noticed. In performing it in the last manner we may observe the following rules:—The solution and precipitant must possess the requisite degree of purity. The solution should be perfectly saturated, to avoid unnecessary expenditure of the solvent or precipitant. The one is to be added slowly and gradually to the other. After each addition, they are to be thoroughly mixed by agitation. We must allow the mixture to settle after we think that enough of the precipitant has been added, and try a little of the clear solution, by adding to it some of the precipitant; if any precipitation takes place, we have not added enough of the precipitant. This is necessary, not only to avoid loss, but in many instances the precipitant, if added in excess, re-dissolves or combines with the precipitate.

After the precipitation is completed, the precipitate is to be separated from the supernatant fluid by some of the means already noticed.

When the precipitate is the chief object of our process, and when it is not soluble in water, it is often advisable to dilute to a considerable degree both the solution and precipitant before performing the operation. When it is only difficultly soluble, we must content ourselves with washing the precipitate after it is separated by filtration. In some cases the separation of the precipitate is much assisted by a gentle heat.

Crystallization is a species of precipitation, in which the particles of the solvend, on separating from the solution, assume certain determinate forms. The conditions necessary for crystallization are, that the integrant particles have a tendency to arrange themselves in a determinate manner, when acted on by the attraction of aggregation; that they be disaggregated, at least so far as to possess sufficient mobility to assume their peculiar arrangement; and that the causes disaggregating them be slowly and gradually removed.

Notwithstanding the immense variety in the forms of crystals, M. Hauy has rendered it probable that there are only three forms of the integrant particles; the parallelopiped, the triangular prism, and the tetrahedron. But as these particles may unite in different ways, either by their faces or edges, they will compose crystals of various forms.

The primitive forms have been reduced to six; the parallelopiped, the regular tetrahedron, the octahedron with triangular faces, the six-sided prism, the dodecahedron terminated by rhombs, the dodecahedron with isosceles triangular faces.

Almost all substances on crystallizing retain a portion of water combined with them, which is essential to their existence as crystals, and is therefore denominated water of crystallization. Its quantity varies very much in different crystallized substances.

The means by which the particles of bodies are disaggregated, so as to admit of crystallization, are solution, fusion, vaporization, or mechanical division and suspension in a fluid medium. The means by which the disaggregating causes are removed are evaporation, reduction of temperature, and rest.

When bodies are merely suspended in a state of extreme mechanical division, nothing but rest is necessary for their crystallization. When they are disaggregated by fusion or vaporization, the regularity of their crystals depends on the slowness with which their temperature is reduced; for if cooled too quickly, their

particles have not time to arrange themselves, and are converted at once into a confused or unvaried solid mass. Thus glass, which when cooled quickly is so perfectly uniform in its appearance, when cooled slowly has a crystalline texture. But in order to obtain crystals by means of fusion, it is often necessary, after the substance has begun to crystallize, to remove the part which remains fluid; for otherwise it would fill up the interstices among the crystals first formed, and give the whole the appearance of one solid mass. Thus, after a crust has formed on the top of melted sulphur, by pouring off the still fluid part we obtain regular crystals.

The means by which bodies which have been disaggregated by solution are made to crystallize most regularly, vary according to the habitudes of the bodies with their solvents and caloric.

Some saline substances are much more soluble in hot than in cold water. Therefore a boiling saturated solution of any of these will deposit, on cooling, the excess of salt, which it is unable to dissolve when cold. These salts commonly contain much water of crystallization. Other salts are scarcely, if at all, more soluble in hot than in cold water; and, therefore, their solutions must be evaporated either by heat or spontaneously. These salts commonly contain little water of crystallization. The beauty and size of the crystals depend upon the purity of the solution, its quantity, and the mode of conducting the evaporation and cooling.

When the salt is not more soluble in hot than in cold water, by means of gentle evaporation a succession of pellicles are formed on the top of the solution, which either are removed or permitted to sink to the bottom by their own weight; and the evaporation is continued until the crystallization be completed. But when the salt is capable of crystallizing on cooling, the evaporation is only continued until a drop of the solution, placed upon some cold body, shews a disposition to crystallize, or at furthest only until the first appearance of a pellicle. The solution is then covered up, and set aside to cool, and the more slowly it cools the more regular are the crystals. The mother-water, or solution which remains after the crystals are formed, may be repeatedly treated in the same way, as long as it is capable of furnishing any more salt.

When very large and beautiful crystals are wanted, they may be obtained by laying well-formed crystals in a saturated solution of the same salt, and turning them every day. In this way their size may be considerably increased, though not without limitation, for after a certain time they grow smaller instead of larger.

Crystallization is employed to obtain crystallizable substances in a state of purity; or to separate them from each other, by taking advantage of their different solubility at different temperatures.

General Analysis resulting from the Application of Chemical Powers.

The simple elementary substances into which bodies are capable of being reduced, submitted to chemical action, are light, caloric, electricity, galvanism, magnetism, oxygen, hydrogen, nitrogen, carbon, sulphur, soda, potash, phosphorus, metals, and earths. Of these the first five have no appreciable gravity, which is evinced by all the rest. Of the latter, again, some are combustible, others incombustible; some oxygenizable, others destitute of all affinity for oxygen. But to enter minutely into these subjects would be to carry us beyond the limits of this article, and to infringe upon those that belong to chemistry as a general science, and to which, as also to the several articles above enumerated in the alphabetical order, we refer the reader for further information. So little progress, however, have we hitherto made in the general science of chemistry, that perhaps we are even now committing a double error, in offering the above as a table of simple elementary substances. It is possible that not one of these substances is, strictly speaking, a simple element, or, in other words, totally uncompounded of rudiments that are more simple. We may also be in an error in conceiving every one of them to be a distinct substance from every other: we have many reasons, for example, for supposing that galvanism and electricity are the very same substance, only in different states of modification; and some philosophers have ventured to suspect that magnetism, or the magnetic power, is, in like manner, in unity with both. Neither soda nor potash, again, are scarcely any longer to be regarded as simple substances; we have many valuable experiments of Mr. Davy before us, by which they appear to have been com-

pletely decomposed; and there can be little doubt of the full confirmation of these experiments by subsequent trials of other chemists. And in this case it is possible that metallic substances will have to be as completely struck out of the list of simple elements as potash or soda. There are also several of the acids which are still admitted into the same catalogue, but whose pretensions are every day becoming still more doubtful, and of which, on this very account, we have taken no notice, though we shall have occasion to advert to them, and especially the muriatic acid, as we proceed. See Light, Caloric, Electricity, &c.

PART II.

PHARMACEUTICAL PREPARATIONS.

The classes into which these are divided have a considerable difference, as well in number as in arrangement, in our different collegiate Pharmacopœias. That of the London College in present use is become perfectly obsolete, both in order and nomenclature. To the nomenclature of the Edinburgh we have little to object, but cannot altogether approve of its order. Why the *Sulphurea* should lead the way, and be so far separated from the *Metallica*, with which they are so intimately connected by nature, we know not. We have reason to believe, that the forthcoming Pharmacopœia of the London College, will, in this, as well as in several other respects, evince a more systematic attention. In the mean time, while we give the general heads of both, we shall take the liberty of arranging them in the following manner:

1. Acida, acids.
2. Alkalina, alkalines.
3. Terrea, earths.
4. Sulphurea, sulphureous preparations.
5. Metallica, metalline preparations.
6. Olea fixata, fixed oils.
7. Aquæ distillatæ, distilled waters.
8. Olea volatilia, volatile oils.
9. Spiritus distillati, distilled spirits.
10. Decocta, decoctions.
11. Infusa, infusions.
12. Syrupi, syrups.
13. Mellita, medicated honeys.
14. Misturæ et emulsiones, mixtures and emulsions.
15. Aceta, medicated vinegars.
16. Tincturæ, tinctures.
17. Ætherea, ethereals and alcohols.
18. Vina, medicated wines.
19. Extracta, extracts.
20. Pulveres, powders.
21. Confectiones, confections.
22. Trochisci, troches.
23. Pilulæ, pills.
24. Cataplasmata, cataplasms.
25. Linimenta, liniments.
26. Unguenta, ointments.
27. Cerata, cerates.
28. Emplastra, plasters.

Class I. *Acida.* Acids.

The preparations under this name chiefly in use, and for which forms are given in the modern College Dispensatories, are

Sulphuric, Edin.
——— diluted, Edin. Lond.
Vitriolic diluted, Edin. Lond.
Nitric, Edin.
Nitrous, Lond. Dubl.
——— diluted, Lond. Dubl.
Muriatic, Edin. Lond. Dubl.
Acetous, Lond. Edin. acetum distil. Dubl.
Benzoic, Edin. Flores Benzoes, Lond.
Succinic, Edin. oleum succini, Lond.
Aqua aëris fixi, Dubl. water impregnated with fixed air.

Nitrous acid is frequently impure. Sulphuric acid is easily got rid of by re-distilling the nitrous acid from a small quantity of nitrate of potash. But its presence is not indicated when nitrous acid forms a precipitate with nitrate of baryte, as affirmed by almost all chemical authors; for nitrate of baryte was discovered by Mr. Hume to be insoluble in nitrous acid.

Muriatic acid is detected by the precipitate formed with nitrate of silver, and may be separated by dropping into the nitrous acid a solution of nitrate of silver, as long as it forms any precipitate, and drawing off the nitrous acid by distillation.

The general properties of nitrous acid have been already noticed. Mr. Davy has shewn, that it is a compound of nitric acid and nitric oxide, and that by additional doses of the last constituent, its colour is successively changed, from yellow to orange, olive-green, and blue-green, and its specific gravity is diminished.

Vinegar may be distilled either in a common still or in a retort. The better kinds of wine-vinegar should be used. Indeed, with the best kind of vinegar, if the

distillation be carried on to any great length, it is extremely difficult to avoid empyreuma. The best method of preventing this inconvenience is, if a retort be used, to place the sand but a little way up its sides, and when somewhat more than half the liquor is come over, to pour on the remainder a quantity of fresh vinegar equal to the liquor drawn off. This may be repeated three or four times; the vinegar supplied at each time being previously heated. The addition of cold liquor would not only prolong the operation, but also endanger the breaking of the retort.

Lowitz recommends the addition of half an ounce of recently burnt and powdered charcoal to each pound of vinegar in the still, as the best means of avoiding empyreuma.

If the common still be employed, it should likewise be occasionally supplied with fresh vinegar, in proportion as the acid runs off, and this continued until the process can be conveniently carried no further. The distilled acid must be rectified by a second distillation in a retort or glass alembic; for although the head and receiver be of glass or stone ware, the acid will contract a metallic taint from the pewter worm.

The residuum of this process is commonly thrown away as useless, although, if skilfully managed, it may be made to turn to good account, the strongest acid still remaining in it. Mixed with about three times its weight of fine dry sand, and committed to distillation in a retort, with a well-regulated fire, it yields an exceedingly strong empyreumatic acid. It is, nevertheless, without any rectification, better for some purposes, as being stronger than the pure acid; particularly for making acetate of potash or soda: for then the empyreumatic oil is burnt out.

Distilled vinegar should be colourless and transparent; have a pungent smell, and purely acid taste, totally free from acrimony and empyreuma, and should be entirely volatile It should not form a black precipitate on the addition of a solution of baryte, or of water saturated with sulphuretted hydrogen; or change its colour when super-saturated with ammonia. These circumstances show that it is adulterated with sulphuric acid, or contains lead, copper, or tin.

Distilled acetous acid, in its effects on the animal economy, does not differ from vinegar, and as it is less pleasant to the taste, it is only used for pharmaceutical preparations.

Class II. *Alkalina.* Alkalines.

The following are the chief preparations under this head:

Carbonas potassæ, carbonate of potash, prepared kali, mild vegetable alkali, salt of tartar.

Potassa, pure kali, caustic vegetable alkali.

Potassa cum calce, lime with pure kali, mild caustic.

Aqua potassæ, Edin. aq. kali puri, Lond. water of potash, caustic ley.

Acetis potassæ, Edin. acetite of potash, acetated kali, Lond.

Sulphas potassæ, Edin. sulphate of potash, vitriolated tartar, vitriolated kali, Lond.

Sulphas potassæ c. sulphure, Edin. sulphate of potash with sulphur, sal polychrest, Lond.

Sulphuretum potassæ, Edin. sulphuret of potash, liver of sulphur.

Tartris potassæ, tartrite of potash, Edin. soluble tartar, tartarised kali, Lond.

Carbonas sodæ, carbonate of soda, Edin. prepared natron, Lond.

Phosphas sodæ, Edin. phosphate of soda.

Murias sodæ, muriate of soda, sea salt.

Sulphas sodæ, Edin. sulphate of soda, natron vitriolatum, Lond Glauber's salt.

Tartris sodæ, Edin. tartrite of soda, natron tartarisatum, Lond. Rochelle salt

Alcohol ammoniatum, Edin. ammoniated alcohol, spirit of ammonia, Lond.

Carbonas ammoniæ, Edin. carbonate of ammonia, prepared ammonia, Lond.

Aqua carbonatis ammoniæ, Edin. water of carbonate of ammonia.

Aqua acetitis ammoniæ, Edin. water of acetite of ammonia, spirit of mindereus.

Hydro sulphuretum ammoniæ, hydro sulphuret of ammonia.

Liquor volutilis cornu cervi, sal et oleum, Lond. spirit oil, and salt of hartshorn.

Class III. *Terrena.* Earths, and Earthy Salts.

The following are the preparations chiefly in use:

Murias barytæ, muriate of baryte, Edin.

Aqua calcis, lime water, Edin. Lond. Dubl.

Carbonas calcis præparatus, prepared chalk, Lond. carbonate of lime, Edin

Phosphas calcis, Edin. phosphate of lime, burnt hartshorn, Lond.

Carbonas magnesiæ, Edin. magnesia alba, Lond. Dubl. carbonate of magnesia.

Phosphas calcis, Edin. magnesia usta, Lond. burnt or calcined magnesia.

Sulphas aluminæ exsiccatus, Edin. dried sulphate of alumine, burnt alum, Lond.

In the Dublin process for making magnesia, there is a mutual decomposition of the two salts employed. The potash unites itself to the sulphuric acid, while the carbonic acid combines with the magnesia. The large quantity of water used is necessary for the solution of the sulphate of potash formed; and the boiling is indispensably requisite for the expulsion of a portion of the carbonic acid, which retains a part of the magnesia in solution. Sulphate of potash may be obtained from the liquor which passes through the filter, by evaporation. This is not pure, however, but mixed with undecomposed carbonate of potash; for one hundred parts of crystallized carbonate of potash are sufficient for the decomposition of one hundred and twenty-five parts of sulphate of magnesia; and as the carbonate of potash of commerce contains a larger proportion of alkali than the crystallized carbonate, a still less proportion should be used. From these quantities about forty-five parts of carbonate of magnesia are obtained.

The ablutions should be made with very pure water; for nicer purposes, distilled water may be used, and soft water is in every case necessary. Hard water for this process is peculiarly inadmissible, as the principle in waters, giving the property called hardness, is generally a salt of lime, which decomposes the carbonate of magnesia, by compound affinity, giving rise to carbonate of lime, while the magnesia unites itself to the acid of the calcareous salt, by which the quantity of the carbonate is not only lessened, but is rendered impure by the admixture of carbonate of lime. Another source of impurity is the silica which the sub-carbonate of potash generally contains. It is most easily got rid of by exposing the alkaline solution to the air for several days before it is used. In proportion as it becomes saturated with carbonic acid, the silica is precipitated, and may be separated by filtration.

The carbonate of magnesia thus prepared, is a very light, white, opaque substance, without smell or taste, effervescing with acids. It is not, however, saturated with carbonic acid. By decomposing sulphate of magnesia by an alkaline carbonate, without the application of heat, carbonate of magnesia is gradually deposited, in transparent, brilliant, hexagonal crystals, terminated by an oblique hexagonal plane, and soluble in about four hundred and eighty times its weight of water. The crystallized carbonate of magnesia consists of fifty acid, twenty-five magnesia, and twenty-five water; the sub-carbonate consists of forty-eight acid, forty magnesia, and twelve water; and the carbonate of commerce of thirty-four acid, forty-five magnesia, and twenty-one water. It is decomposed by all the acids, potash, soda, baryte, lime, and strontian, the sulphate, phosphate, nitrate, and muriate of alumina, and the super-phosphate of lime.

Class IV. Sulphurea.

The preparations under this head are few; we need only enumerate the two following:

Sulphur lotum, Lond. washed flowers of sulphur.

Sulphur præcipitatum, Lond. precipitated sulphur.

In preparing this last, instead of dissolving sulphuret of potash in water, we may gradually add sublimed sulphur to a boiling solution of potash, until it be saturated. When the sulphuretted potash is thrown into water, it is entirely dissolved, but not without decomposition, for it is converted into sulphate of potash, hydroguretted sulphuret of potash, and sulphureted hydroguret of potash. The two last compounds are again decomposed on the addition of any acid. The acid combines with the potash, sulphuretted hydrogen flies off in the form of gas, while sulphur is precipitated. It is of little consequence what acid is employed to precipitate the sulphur. The London College order the sulphuric; while the Dublin College use nitrous acid; probably because the nitrate of potash formed is more easily washed away than sulphate of potash.

Precipitated sulphur does not differ from well-washed sublimed sulphur, except in being much dearer. Its paler colour is owing to its more minute division, or, according to Dr. Thomson, to the presence of a little water; but from either circumstance it derives no superiority to compensate for the disagreeableness of its preparation.

These are all the more simple preparations of sulphur in common use. There are various preparations into which sulphur enters as an ingredient; but such as constituting compounds of the general

nature of metals, alkalies, oils, &c. will be found under under those classes.

Class V. *Metallica.* Metalline Preparations.

The metalline preparations are very numerous, especially those of antimony and quicksilver.

Sulphuretum antimonii præparatum, Edin. prepared antimony.

Oxidum antim. cum sulphure per nitratem potassæ, Edin. crocus of antimony, Lond.

Oxidum antimonii, cum sulphure, vitrificatum, vitrified antimony, Lond. glass of antimony.

Sulphuretum antimonii præcipitatum, precipitated sulphuret, or sulphur of antimony, Lond.

Murias antimonii, Edin. muriated antimony, Lond. butter of antimony.

Oxidum antimonii cum phosphate calcis, Edin. pulvis antimonialis, Lond. antimonial powder.

Tartris antimonii, tartarised, or tartrite of antimony.

Vinum tartritis antimonii, Edin. tartar emetic, antimonial wine, Lond.

Nitras argenti, Edin. argentum nitratum, Lond. nitrate of silver, lunar caustic.

Ærugo præparata, Lond. Dub. prepared verdigrise, or carbonate of copper.

Solutio sulphatis cupri composita, Edin. styptic water.

Ammoniaretum cupri, Edin. ammoniacal copper.

Aqua cupri ammoniati, Lond. water of the same.

Ferri limatura purificata, Edin, purified iron filings.

Carbonas ferri, Edin. rubigo ferri, Lond. carbonate, or rust of iron.

Sulphas ferri, Edin. vitriolated iron, Lond. sulphate of iron.

Tinctura muriatis ferri, tincture of muriate of iron, Lond.

Murias ammoniæ et ferri, martial flowers, ammoniacal iron, Lond.

Tinctura ejusdem, tincture of the same.

Tartris ferri, tartrite of, or tartarised, iron, Lond.

Vinum ferri, Lond. wine of iron.

Hydrargyrus purificatus, Lond. purified quicksilver.

Acetis hydrargyri acetite, Edin. of quicksilver.

Murias hydrargyri, Edin. Lond. muriate of quicksilver, corrosive sublimate.

Submurias hydrargyri, Edin. calomel, Lond.

Submurias hydrargyri præcipitatus, Edin. mild muriated quicksilver, Lond.

Calx hydrargyri alba, Lond. white precipitate.

Hydrargyrus calcinatus, Dub. Lond. calcined quicksilver.

Oxydum hydrargyri rubrum, Edin. red precipitate.

Subsulphas hydrargyri flavus, Edin. vitriolated quicksilver, Lond.

Sulphuretum hydrargyri nigrum, Edin. æthiops mineral, turpeth mineral.

Hydrargyrum sulphuratum nibrum, Lon. Dub. factitious cinnabar.

Acetis plumbi, Edin. acetite of lead, sugar of lead.

Aqua lithargyri acetata, Lond. extract of lead.

Cerussa acetata, Lond. acetated ceruse.

Stanni pulvis, Lond. powder of tin.

Oxydum zinci, Edin. oxide of zinc, calcined zinc, Lond.

Carbonas zinci, Edin. impurus præparatus, prepared calamine.

Oxydum zinci impurum præparatum, Edin. prepared tutty.

Sulphas zinci, Edin. vitriolated zinc, Lond.

The antimonial powder of the London College is supposed to be nearly the same with the celebrated nostrum of Dr. James, the composition of which was ascertained by Dr. Pierson of London, to whom we are also indebted for the above formula.

By burning sulphuret of antimony and shavings of hartshorn in a white heat, the sulphur is entirely expelled, and the antimony is oxydized, while the gelatine of the hartshorn is destroyed, and nothing is left but phosphate of lime, combined with a little lime. Therefore the mass which results is a mixture of oxide of antimony and phosphate of lime, which corresponds, at least as to the nature of the ingredients, with James's powder, which, by Dr. Pearson's analysis, was found to consist of 43 phosphate of lime, and 57 oxide of antimony. Another excellent chemist, M. Chenevix, has lately proposed a method of forming the same combination in the humid way, with the view of obtaining a preparation always similar in its composition and properties. He was led to this proposal, by considering the uncertainty of the application, and the precarious nature of the agency of fire, by which means a variable portion of the oxide of antimony may be volatalised, and that which remains may be oxydized in various degrees.

M. Chenevix, therefore, proposes to prepare a substitute for James's powder, by dissolving together equal weights of

submuriate of antimony and of phosphate of lime in the smallest possible quantity of muriatic acid, and then pouring this solution gradually into water sufficiently alkalized with ammonia. For the reason mentioned in the preceding article, it is absolutely necessary that the muriatic solution be poured into the alkaline liquor. By an opposite mode of procedure, the precipitate would contain more antimony at first, and towards the end the phosphate of lime would be predominant, and the antimony would be partly in the state of a submuriate. The phosphate of lime is most conveniently obtained pure by dissolving calcined bone in muriatic acid, and by precipitating it by ammonia. If the ammonia be quite free from carbonic acid, no muriate of lime is decomposed. M. Chenevix also found that his precipitate is entirely soluble in every acid which can dissolve either phosphate of lime or oxide of antimony separately, and that about 0.28 of James's powder, and at an average 0.44 of the pulvis antimonialis of the London Pharmacopœia, resist the action of every acid.

Class VI. *Olea Fixata.* Fixed Oils.

These oils are improperly denominated expressed, which is their usual characteristic name, as in some instances they are obtained without expression, and in other instances expression is employed to obtain volatile oils. The Edinburgh college have therefore distinguished these different classes of oils by the terms fixed and volatile, which accurately characterize them.

Fixed oil is formed in no other part of vegetables than in their seeds. Sometimes, although very rarely, it is contained in the parenchyma of the fruit. Of this, the best known example is the olive. But it is most commonly found in the seeds of dicotyledonous vegetables, sometimes also in the fruit of monocotyledonous plants, as the cocos butyracea. It has various degrees of consistency, from the tallow of the croton sebiferum of China, and the butter of the butter-tree of Africa, to the fluidity of olive oil.

Fixed oils are either, 1. Fat, easily congealed, and not inflammable by nitric acid, oil of olives, almonds, rapeseed, and ben. 2. Drying, not congealable, inflammable by nitric acid, oil of linseed, nut, and poppy. 3. Concrete oils, palm oil, &c.

Fixed oil is separated from fruits and seeds which contain it, either by expression or decoction. Heat, by rendering the oil more limpid, incre[illegible]s very much the quantity obtained by expression; but as it renders it less bland, and more apt to become rancid, heat is not used in the preparation of oils which are to be employed in medicine. When obtained by expression, oils often contain a mixture of mucilage, starch, and colouring matter; but part of these separate in course of time, and fall to the bottom. When oils become rancid, they are no longer fit for internal use, but are then said to effect the killing of quick-silver, as it is called, more quickly. Decoction is principally used for the extraction of the viscid and consistent oils, which are melted out by the heat of the boiling water, and rise to its surface.

Those who prepare large quantities of the oil of almonds, blanch them, by steeping them in very hot water, which causes their epidermis to swell, and separate easily. After they peel them, they dry them in a stove, then grind them in a mill like a coffee mill, and lastly, express the oil from the paste inclosed in a hempen bag. By blanching the almonds, the paste which remains within the bag is sold with greater advantage to the perfumers, and the oil obtained is perfectly colourless. But the heat employed disposes the oil to become rancid, and the colour the oil acquires from the epidermis does not injure its qualities. For pharmaceutical use, therefore, the oil should not be expressed from blanched almonds, but merely rubbed in a piece of coarse linen, to separate the brown powder adhering to the epidermis as much as possible. Sixteen ounces of sweet almonds commonly give five ounces and a half of oil. Bitter almonds afford the same proportions, but the oil has a pleasant bitter taste.

In this manner are to be expressed,

Oleum amygdalæ, almond oil, from the kernel.

Oleum lini, linseed oil from the bruised seeds.

Oleum ricini, castor oil, from the seeds previously decorticated.

Oleum sinapeos, oil of mustard, from the bruised seeds.

Class VII. *Aquæ Distillatæ.* Distilled Waters.

Substances which differ in volatility, may be separated from each other by applying a degree of heat capable of converting the most volatile into vapour, and

by again condensing this vapour in a proper apparatus. Water is converted into vapour at 212°, and may be separated by distillation from the earthy and saline matters which it always contains in a natural state. But, it is evident, that if any substances which are as volatile as water, be exposed to the same degree of heat, either by immersing them in boiling water, or exposing them to the action of its steam, they will rise with it in distillation. In this way the camphor and volatile oils of vegetable substances are separated from the more fixed principles; and as water is capable of dissolving a certain quantity of these volatile substances, it may be impregnated with a great variety of flavours by distilling it from different aromatic substances. If the subject of our distillation contain more volatile oil than the water employed is capable of dissolving, it will render the water milky, and afterwards separate from it. It is in this way that essential oils are obtained.

Essential oils are obtained only from odoriferous substances; but not equally from all of this class, nor in quantity proportional to their degree of odour. Some, which, if we were to reason from analogy, should seem very well fitted for this process, yield extremely little oil, and others none at all. Roses and camomile flowers, whose strong and lasting smell promises abundance, are found to contain but a small quantity of oil; the violet and jessamine flower, which perfume the air with their odour, lose their smell upon the gentlest coction, and do not afford any oil, on being distilled, unless immense quantities are submitted to the operation at once; while savin, whose disagreeable scent extends to no great distance, gives out the largest proportion of oil of almost any vegetable known.

Nor are the same plants equally fit for this operation, when produced in different soils or seasons, or at different times of their growth. Some yield more oil, if gathered when the flowers begin to fall off, than at any other time. Of this we have examples in lavender and rue; others, as sage, afford the largest quantity when young, before they have sent forth any flowers; and others, as thyme, when the flowers have just appeared. All fragrant herbs yield a larger proportion of oil, when produced in dry soils and in warm summers, than in opposite circumstances. On the other hand, some of the disagreeable strong-scented ones, as worm-wood, are said to contain most oil in rainy seasons, and when growing in moist rich grounds.

Several chemists have been of opinion, that herbs and flowers moderately dried, yield a greater quantity of essential oil, than if they were distilled when fresh. It is, however, highly improbable, that the quantity of essential oil will be increased by drying; on the contrary, part of it must be dissipated and lost. But drying may sometimes be useful in other ways; either by diminishing the bulk of the subject to be distilled, or by causing it to part with its oil more easily.

The choice of proper instruments is of great consequence for the performance of this process to advantage. There are some oils which pass freely over the swan-neck of the head of the common still: others, less volatile, cannot easily be made to rise so high. For obtaining these last, we would recommend a large low head, having a rim or hollow canal round it: in this canal the oil is detained in its first ascent, and thence conveyed at once into the receiver, the advantages of which are sufficiently obvious.

With regard to the proportion of water to be employed; if whole plants, moderately dried, are used, or the shavings of woods, as much of either may be put into the vessel, as, lightly pressed, will occupy half its cavity; and as much water may be added as will fill two thirds of it. When fresh and juicy herbs are to be distilled, thrice their weight of water will be fully sufficient; but dry ones require a much larger quantity. In general, there should be so much water, that after all intended to be distilled has come over, there may be liquor enough left to prevent the matter from burning to the still. The water and ingredients, altogether, should never take up more than three fourths of the still; there should be liquor enough to prevent any danger of an empyreuma, but not so much as to be apt to boil over into the receiver.

The subject of distillation should be macerated in the water until it be perfectly penetrated by it. To promote this effect, woods should be thinly shaved across the grain, or sawn, roots cut transversely into thin slices, barks reduced into coarse powder, and seeds slightly bruised. Very compact and tenacious substances require the maceration to be continued a week or two, or longer; for those of a softer and looser texture, two or three days are sufficient; while some tender herbs and flowers not only stand

in no need of maceration, but are even injured by it. The fermentation which was formerly prescribed in some instances, is always hurtful.

With regard to the fire, the operator ought to be expeditious in raising it at first, and to keep it up during the whole process, to such a degree only, that the oil may freely distil; otherwise the oil will be exposed to an unnecessary heat; a circumstance which ought as much as possible to be avoided. Fire communicates to all these oils a disagreeable impregnation, as is evident from their being much less grateful when newly distilled, than after they have stood for some time in a cool place: and the longer the heat is continued, the greater alteration it produces in them.

The greater number of oils require for their distillation the heat of water strongly boiling: but there are many also which rise with a heat considerably less; such as those of lemon and citron peel; of the flowers of lavender and rosemary, and of almost all the more odoriferous kinds of flowers. We have already observed, that these flowers have their fragrance much injured, or even destroyed, by beating or bruising them; it is impaired also by the immersion in water in the present process, and the more so in proportion to the continuance of the immersion and the heat; hence oils, distilled in the common manner, prove much less agreeable in smell than the subjects themselves. For the distillation of substances of this class, another method has been contrived; instead of being immersed in water, they are exposed only to its vapour. A proper quantity of water being put into the bottom of the still, the odoriferous herbs or flowers are laid lightly in a basket, of such a size that it may enter into the still, and rest against its sides just above the water. The head being then fitted on, and the water made to boil, the steam, percolating through the subject, imbibes the oil, without impairing its fragrance, and carries it over into the receiver. Oils thus obtained, possess the odour of the subject in an exquisite degree, and have nothing of the disagreeable scent perceivable in those distilled by boiling them in water in the common manner.

Plants differ so much, according to the soil and season of which they are the produce, and likewise according to their own ages, that it is impossible to fix the quantity of water to be drawn from a certain weight of them to any invariable standard. The distillation may always be continued as long as the liquor runs well flavoured off the subject, but no longer.

In the distillation of essential oils, the water, as was observed in the foregoing section, imbibes always a part of the oil. The distilled liquors here treated of, are no other than water thus impregnated with the essential oil of the subject; whatever smell, taste, or virtue, is communicated to the water, or obtained in the form of watery liquor, being found in a concentrated state in the oil.

All those vegetables, therefore, which contain an essential oil, will give over some virtue to water by distillation: but the degree of the impregnation of the water, or the quantity of water which the plant is capable of saturating with its virtue, are by no means in proportion to the quantity of its oil. The oil saturates only the water that comes over at the same time with it: if there be more oil than is sufficient for this saturation, the surplus separates, and concretes in its proper form, not miscible with the water that arises afterwards. Some odoriferous flowers, whose oil is in so small quantity that scarcely any visible mark of it appears, unless fifty or an hundred pounds or more are distilled at once, give nevertheless as strong an impregnation to water as those plants which abound most with oil.

Many have been of opinion, that distilled waters may be more and more impregnated with the virtues of the subject, and their strength increased to any assigned degree, by cohobation, that is, by re-distilling them repeatedly from fresh parcels of the plant; experience, however, shews the contrary. A water, skilfully drawn in the first distillation, proves, on every repeated one, not stronger, but more disagreeable. Aqueous liquors are not capable of imbibing above a certain quantity of the volatile oil of vegetables; and this they may be made to take up by one, as well as by any number of distillations: the oftener the process is repeated, the ungrateful impression which they generally receive from the fire, even at the first time, becomes greater and greater.

Those plants which do not yield at first waters sufficiently strong, are not proper subjects for this process.

The mixture of water and oil which comes over, may either be separated immediately, by means of a separatory, or after it has been put into large narrow-necked bottles, and placed in a cool place, that the portion of oil which is not dis-

solved in the water, may rise to the top, or sink to the bottom, according to its specific gravity. It is then to be separated, either by a separatory, or by means of a small glass syringe; or by means of a filter of paper; or, lastly, by means of a woollen thread, one end of which is immersed in the oil, and the other lower end in a phial: the oil will thus pass over into the phial by capillary attraction, and the thread is to be squeezed dry.

Most distilled waters, when first prepared, have a somewhat unpleasant smell, which, however, they gradually lose: it is therefore advisable to keep them for some days after their preparation in vessels but slightly covered; and not to cork them up until they lose that smell.

That the waters may keep the better, about one-twentieth part of their weight of proof spirit may be added to each after they are distilled. I have been informed by a respectable apothecary, that if the simple distilled waters be rectified, by distilling them a second time, they will keep for several years without the addition of any spirit, which always gives an unpleasant flavour, and is often objectionable for other reasons.

Distilled waters are employed chiefly as grateful diluents, as suitable vehicles for medicines of greater efficacy, or for rendering disgustful ones more acceptable to the palate and stomach: few are depended on, with any intention of consequence by themselves.

To the chapter on simple distilled waters, the London college have annexed the following remarks.

"We have ordered most of the waters to be distilled from the dried herbs, because fresh are not ready at all times of the year. Whenever the fresh are used, the weights are to be increased. But, whether the fresh or dried herbs be employed, the operator may vary the weight according to the season in which they have been produced and collected."

Herbs and seeds kept beyond the space of a year, become less proper for the distillation of waters.

To every gallon of these waters add five ounces, by measure, of proof spirit.

The Edinburgh college order half an ounce of proof spirit to every pound of the water, which is nearly the same.

But the Dublin college order five ounces of proof spirit to be added to each pound, which is probably a typographical error.

Water itself is ordered to be distilled, to give it greater purity; and the substances from which distilled waters are to be drawn, are as follows: the weight of each being sufficient for a gallon.

Two pounds of fresh orange-peel, Edin.

Aqua citri aurantii.

One pound of sweet fennel seeds bruised, Lond. Dubl.

Aqua fœniculi dulcis.

Six pounds of the recent petals of the damask rose.

Aqua rosæ centifoliæ, Edin.
Aqua rosæ, Lond. Dub.

Three pounds, Edin. one pound and a half, Lond. Dubl. of peppermint.

Aqua menthæ piperitæ, Edin.
Aqua menthæ piperitidis, Lond. Dub.

Three pounds, Edin. one pound and a half, Lond. Dubl. of pennyroyal, in flower,

Aqua menthæ pulegii, Edin.
Aqua pulegii, Lond. Dubl.

Two pounds of fresh lemon peel,

Aqua citri medicæ, Edin.

One pound and a half of spearmint.

Aqua menthæ sativæ, Lond. Dub.

One pound of cinnamon, (macerated for a day) Lond. Dubl.

Aqua lauri cinnamoni, Edin.
Aqua cinnamoni, Lond. Dubl.

One pound of cassia,

Aqua lauri cassiæ, Edin.

One pound of bruised dill seeds,

Aqua anethi, Lond.

Half a pound of pimento, (macerated for a day) Lond.

Aqua myrti pimentæ, Edin.
Aqua pimento, Lond.

The virtues of all these waters are nearly alike; and the peculiarities of each will be easily understood by consulting the account given in the materia medica, of the substance from which they are prepared. Mr. Nicholson mentions, that as rose-water is exceedingly apt to spoil, the apothecaries generally prepare it in small quantities at a time from the leaves, preserved by packing them closely in cans with common salt. This we understand is not the practice in Edinburgh, and indeed cannot suceeed with the petals of the damask rose, for they lose their smell by drying. The London apothecaries, therefore, probably use the red rose. The spoiling of some waters is owing to some mucilage carried over in the distillation; for, if rectified by a second distillation, they keep perfectly.

Class VIII. *Olea Volatilia.* Volatile Oils.

These are prepared nearly in the same manner as distilled waters, except that less water is to be added.

Seeds, and woody substances, are to be previously bruised, or rasped. The oil comes over with the water, and is afterwards to be separated from it, according as it may be lighter than the water, and swim upon its surface, or heavier, and sink to the bottom.

Besides, in preparing distilled waters and oils, it is to be observed, that the goodness of the subject, its texture, the season of the year, and similar causes, must give rise to so many differences, that no certain or general rule can be given to suit accurately each example. Hence, the following is the mode prescribed by the London College.

According to these directions are prepared the volatile, distilled, or essential, oils; or olea volatilia, Edin. distilla, Dub. vel essentialia, Lond.

Anise, pimpinellæ anisi, Edin. anisi, Lon. Dub.

Caraway, carui, Lond. Dub.

Fennel seeds, seminum fœniculi dulcis. Dub. from the seeds.

Juniper berries, juniperi communis, Edin. baccarum juniperi, Dub. juniperi baccæ, Lond. from the berries.

Pimento, myrti pimentæ, Edin. from the fruit.

Fennel flowers, florum fœniculi dulcis, Dub.

Rosemary, rorismarini officinalis, Edin. rorismarini, Lond. Dub.

Lavender, lavandulæ spicæ, Edin. lavendulæ, Lond.

Peppermint, menthæ piperitæ, Edin. menthæ piperitidis, Lond. Dub.

Spearmint, menthæ sativæ, Lond. Dub.

Pennyroyal, pulegii, Lond. Dub.

Origanum, origani, Lond. Dub.

Rue, rutæ, Dub.

Savine, juniperi sabinæ. Edin. sabinæ. Dub. from the flower, or herb in flower.

Sassafras, lauri sassafras, Edin. sassafras, Lond. from the root.

And, turpentine, pinus picea, from the resin.

The residuum, after the oil has been extracted, is the officinal resin (resina flava): and a rectified spirit is obtained by distilling the oil of turpentine with four times its weight of water.

The spirit of turpentine, as this essential oil has been styled, is frequently taken internally as a diuretic and sudorific; and it has sometimes a considerable effect when taken to the extent of a few drops only. It has, however, been given in much larger doses, especially when mixed with honey. Recourse has principally been had to such doses in cases of chronic rheumatism, particularly in those modifications of it which are termed sciatica and lumbago; but sometimes it induces bloody urine.

The water employed in the distillation of volatile oils always imbibes some portion of the oil; as is evident from the smell, taste, and colour, which it acquires. It cannot, however, retain above a certain quantity; and, therefore, such as has been already used and almost saturated itself, may be advantageously employed, instead of common water, in a second, third, or any future distillation of the same subject.

After the distillation of one oil, particular care should be had to clean the worm perfectly before it be employed in the distillation of a different substance. Some oils, those of wormwood and aniseeds for instance, adhere to it so tenaciously, as not to be melted out by heat, or washed off by water; the best way of removing these, is to run a little spirit of wine through it.

Volatile oils, after they are distilled, should be suffered to stand for some days, in vessels loosely covered with paper, till they have lost their disagreeable fiery odour, and become limpid; then put them up in small bottles, which are to be kept quite full, closely stopped, in a cool place. With these cautions, they will retain their virtues in perfection for many years.

Most of the oils mentioned above, are prepared by our chemists in Britain, and are easily procurable in a tolerable degree of perfection; but the oils from the more expensive spiceries, though still introduced among the preparations in the foreign pharmacopœias, are, when employed among us, usually imported from abroad.

These are frequently so much adulterated that it is not easy to meet with such as are at all fit for use. Nor are these adulterations easily discoverable. The grosser abuses, indeed, may be readily detected. Thus, if the oil be mixed with spirit of wine it will turn milky on the addition of water; if with expressed oils, rectified spirit will dissolve the volatile, and leave the other behind; if with oil of turpentine, on dipping a piece of paper

in the mixture, and drying it with a gentle heat, the turpentine will be betrayed by its smell. But the more subtile artists have contrived other methods of sophistication, which elude all trials of this kind.

Some have looked upon the specific gravity of oils as a certain criterion of their genuineness. This, however, is not to be absolutely depended on; for the genuine oils obtained from the same subjects, often differ in gravity, as much as those drawn from different ones. Cinnamon and cloves, whose oils usually sink in water, yield, if slowly and warily distilled, oils of great fragrancy, which are nevertheless specifically lighter than the aqueous fluid employed in their distillation; whilst, on the other hand, the last runnings of some of the lighter oils prove sometimes so ponderous as to sink in water.

As all volatile oils agree in the general properties of solubility in spirit of wine, indissolubility in water, miscibility with water by the intervention of certain intermedia, volatility in the heat of boiling water, &c. it is plain that they may be variously mixed with each other, or the dearer sophisticated with the cheaper, without any possibility of discovering the abuse by any trials of this kind. And, indeed, it would not be of much advantage to the purchaser, if he had infallible criteria of the genuineness of every individual oil. It is of as much importance that they be good, as that they be genuine; for genuine oils from inattentive distillation, and long and careless keeping, are often weaker both in smell and taste than the common sophisticated ones.

The smell and taste seem to be the only certain tests of which the nature of the thing will admit. If a bark should have, in every respect, the appearance of good cinnamon, and should be proved indisputably to be the genuine bark of the cinnamon tree; yet if it want the cinnamon flavour, or has it but in a low degree, we reject it; and the case is the same with the oil. It is only from use and habit, or comparisons with specimens of known quality, that we can judge of the goodness either of the drugs themselves, or of their oils.

Most of the volatile oils indeed are too hot and pungent to be tasted with safety; and the smell of the subject is so much concentrated in them, that a small variation in this respect is not easily distinguished; but we can readily dilute them to any assignable degree. A drop of the oil may be dissolved in spirit of wine, or received on a bit of sugar, and dissolved by that intermedium in water. The quantity of liquor which it thus impregnates with its flavour, or the degree of flavour which it communicates to a certain determinate quantity, will be the measure of the degree of goodness of the oil.

Medical use. Volatile oils, medicinally considered, agree in the general qualities of pungency and heat; in particular virtues they differ as much as the subjects from which they are obtained, the oil being the direct principle in which the virtues, or at least a considerable part of the virtues, of the several subjects reside. Thus the carminative virtue of the warm seeds, the diuretic of juniper berries, the emmenagogue of savin, the nervine of rosemary, the stomachic of mint, the antiscorbutic of scurvy-grass, the cordial of aromatics, &c. are supposed to be concentrated in their oils.

There is another remarkable difference in volatile oils, the foundation of which is less obvious, that of the degree of their pungency and heat. These are by no means in proportion, as might be expected, to those of the subject they were drawn from. The oil of cinnamon, for instance, is excessively pungent and fiery; in its undiluted state it is almost caustic; whereas cloves, a spice which in substance is far more pungent than the other, yields an oil which is far less so. This difference seems to depend partly upon the quantity of oil afforded, cinnamon yielding much less than cloves, and consequently having its active matter concentrated into a smaller volume; partly, upon a difference in the nature of the active parts themselves: for though volatile oils contain always the specific odour and flavour of their subjects, whether grateful or ungrateful, they do not always contain the whole pungency: this resides frequently in a more fixed matter, and does not rise with the oil. After the distillation of cloves, pepper, and some other spices, a part of their pungency is found to remain behind: a simple tincture of them in rectified spirit of wine is even more pungent than their pure essential oils.

The more grateful oils are frequently made use of for reconciling to the stomach medicines of themselves disgustful. It has been customary to employ them as correctors for the resinous purgatives;

an use which they do not seem to be well adapted to. All the service they can here be of is, to make the resin sit more easily at first on the stomach: far from abating the irritating quality upon which the violence of its operation depends, these pungent oils superadd a fresh stimulus.

Volatile oils are never given alone, on account of their extreme heat and pungency; which in some is so great, that a single drop let fall upon the tongue produces a gangrenous eschar. They are readily imbibed by pure dry sugar, and in this form may be conveniently exhibited. Ground with eight or ten times their weight of sugar they become soluble in aqueous liquors, and thus may be diluted to any assigned degree. Mucilages also render them miscible with water into an uniform milky liquor. They dissolve likewise in spirit of wine; the more fragrant in an equal weight, and almost all of them in less than four times their own quantity. These solutions may be either taken on sugar, or mixed with syrups, or the like. On mixing them with water, the liquor grows milky, and the oil separates.

The more pungent oils are employed externally against paralytic complaints, numbness, pains, and aches, cold tumours, and in other cases where particular parts require to be heated or stimulated. The tooth-ache is sometimes relieved by a drop of these almost caustic oils, received on cotton, and cautiously introduced into the hollow tooth.

Among the volatile oils ought also to be enumerated the empyreumatic oils; for these also are volatile, but have a character peculiar to themselves. The simple volatile oils exist ready formed in the aromatic substances from which they are obtained, and are only separated from the fixed principles by the action of a heat not exceeding that of boiling water. The empyreumatic, on the contrary, are always formed by the action of a degree of heat considerably higher than that of boiling water, and are the product of decomposition, and a new arrangement of the elementary principles of substances, containing at least oxygen, hydrogen, and carbon. Their production is therefore always attended with the formation of other new products. In their chemical properties they do not differ very remarkably from the volatile oils, and are principally distinguished from them by their unpleasant, pungent smell, and rough, bitterish taste. The following are the chief:

Oleum petrolei, oil of bitumen, or tar.

Oleum succini, oil of amber, which is afterwards rectified.

Oleum animale, animal oil, obtained from hartshorn, which also is rectified by being again distilled with water.

Class IX. *Spiritus Distillati.* Distilled Spirits.

The flavour and virtues of distilled waters are owing, as observed in the preceding chapter, to their being impregnated with a portion of the essential oil of the subject from which they are drawn. Alcohol, considered as a vehicle for these oils, has this advantage above water, that it keeps all the oil that rises with it perfectly dissolved into an uniform limpid liquor.

Nevertheless many substances, which, on being distilled with water, impart to it their virtues in great perfection; if treated in the same manner with alcohol, scarcely give over to it any smell or taste. The cause of this difference is, that alcohol is not susceptible of so great a degree of heat as water. It is obvious, therefore, that substances may be volatile enough to rise with the heat of boiling water, but not with that of boiling alcohol.

Thus, if cinnamon, for instance, be committed to distillation with a mixture of alcohol and water, or with a pure proof spirit, which is no other than a mixture of about equal parts of the two, the alcohol will arise first clear, colourless, and transparent, and almost without any taste of the spice; but as soon as the more ponderous watery fluid begins to arise, the oil comes freely over with it, so as to render the liquor highly odorous, sapid, and of a milky hue.

The proof spirits usually met with in the shops are accompanied with a degree of ill flavour, which, though concealed by means of certain additions, plainly discovers itself in distillation. This nauseous flavour does not begin to arise till after the purer spirituous part has come over, which is the very time that the virtues of the ingredients begin also to arise most plentifully; and hence the liquor receives an ungrateful taint. To this cause principally is owing the general complaint, that the cordials of the apothecary are less agreeable than those of the same kind prepared by the distiller; the latter being extremely curious in rectifying or purifying the spirits (when designed for what he calls fine goods) from all unpleasant flavour.

Spiritus cari carvi, Edin. spirit of caraway. Take of caraway seeds half a pound; diluted alcohol nine pounds. Macerate two days in a close vessel; then pour on as much water as will prevent empyreuma, and draw off by distillation nine pounds.

Spiritus carvi, Lond. Dub. spirit of caraway. Take of caraway seeds, bruised, half a pound; proof spirit of wine one gallon; (nine pounds, Dub.) water sufficient to prevent empyreuma. Draw off one gallon, (nine pounds, Dub.)

In the same manner is prepared the same quantity of spirit from

Cinnamon, one pound,
Spiritus lauri cinnamomi, Edin.
Spiritus cinnamomi, Lond. Dub.
Peppermint, one pound and a half.
Spiritus menthæ piperitæ, Edin.
Spiritus menthæ piperitidis, Lond.
Spearmint, one pound and a half,
Spiritus menthæ sativæ, Lond.
Pennyroyal dried, a pound and a half,
Spiritus pulegii, Lond.
Nutmeg, well bruised, two ounces,
Spiritus myristicæ moschatæ, Edin.
Spiritus nucis moschatæ, Dub. Lond.
Pimento, half a pound,
Spiritus myrti pimentæ, Edin.
Spiritus pimento, Dub. Lond.

The rest belonging to this division are obtained from

Lavender,
Spiritus lavendulæ, Lond.
Spiritus lav. spicæ, Edin.
Rosemary,
Spiritus rorismarini, Lond. Edin.
Anice, &c.
Spiritus anisi compositus, Lond.
Juniper, &c.
Spiritus juniperi compositus, Lond. Edin. Dub.
Horse-radish, &c.
Spiritus raphani compositus, Lond. Dub.
Assafœtida,
Spiritus Ammoniæ fœtidus, Lond.

Class X. *Decocta.* Decoctions.

Decoctions and infusions differ chiefly in the employment of boiling or of cold water. At the same time, however, that the increase of temperature in decoctions facilitates and expedites the solution of some fixed principles, it gives others a tendency to decomposition, and dissipates all volatile matters. Decoction, therefore, can only be used with advantage for the extraction of principles which are neither volatilized nor altered by a boiling heat.

To promote the action of the menstruum, infusion is sometimes premised to decoction.

In compound decoctions it is sometimes convenient not to put in all the ingredients from the first, but in succession, according to their hardness, and the difficulty with which their virtues are extracted; and if any aromatic, or other substances containing volatile principles, enter into the composition, the boiling decoction is to be simply poured upon them, and covered up until it cool.

Decoctions should be made in vessels sufficiently large to prevent any risk of boiling over, and should be continued without interruption, and gently.

The official preparations under this class are

Decoctum altheæ officinalis, Edin. decoction of marshmallows.

Decoctum anthemidis nobilis, Edin. decoctum chamemæli, Lond. decoction of camomile flowers.

Decoctum cinchonæ officinalis, Lond. Edin decoction of Peruvian bark.

Decoctum daphnes mezerei, Edin. decoction of mezereon.

Decoctum geoffreæ inermis, Edin. decoction of cabbage-tree bark.

Decoctum guaiaci officinalis comp. Edin. decoction of the woods.

Decoctum hellebori albi, Lond. decoction of white hellebore.

Decoctum hordei Lond. hord. distichi, Edin. decoction of barley.

Decoctum polygalæ senegæ, Edin. decoction of seneka.

Decoctum sarsaparillæ, Lond. Dubl. decoctum smilacis sarsaparillæ, Edin. decoction of sarsaparilla.

Decoctum smilacis sarsaparillæ, Edin. decoctum smilacis sarsaparilla, comp. Dubl. Lond. decoction of compound of the same.

Decoctum ulmi, Lond. decoction of elm.

Class XI. *Infusa.* Infusions.

We have already explained the sense in which we employ the term infusion. We confine it to the action of a menstruum, not assisted by ebullition, on any substance consisting of heterogeneous principles, some of which are soluble, and others insoluble, in that menstruum. The term is generally used in a more extensive, but, we are inclined to think, a less correct sense. Thus, lime water and the

mucilages, which are commonly classed with the infusions, are instances of simple solution, and the chalk mixture is the mechanical suspension of an insoluble substance. When the menstruum used is water, the solution is termed simply an infusion; but when the menstruum is alcohol, and upon a colouring material, it is called a tincture; when wine or vinegar, a medicated wine or vinegar. Infusions in water are extremely apt to spoil, and are generally extemporaneous preparations.

The following are those officially prescribed:

Infusum cinchonæ, Edin. infusion of Peruvian bark.

Infusum digitalis purpureæ, Edin. infusion of fox-glove.

Infusum gentianæ compositum Lond. Infusum gentianæ luteæ comp. Edin. infusion of gentian, compound.

Infusum mimosæ catechu, Edin. infusion of catechu.

Infusum rhei palmati, Edin. infusion of rhubarb.

Infusum rosæ, Lond. infusum rosæ Gallicæ, Edin. infusion of roses.

Infusum sennæ, Lond. Dubl. infusion of senna.

Infusum sennæ tartarisatum, Lond. infusion of senna tartarised.

Infusum tamarindi Ind. cum cassia senna, Edin. infusion of tamarinds and senna.

Class XII. *Mucilagines.* Mucilages.

These, as officially prescribed, are as follow:

Mucilago amyli Lond. Edin. mucilage of starch.

Mucilago tragacanthæ, Lond. mucilago astragali tragac. Edin. mucilago gummi tragac, Dubl. mucilage of tragacanth.

Mucilago mimosæ niloticæ, Edin. mucilago gummi arabici, Lond. mucilage of gum arabic.

Mucilago sem. cydonii mali, Lond. mucilage of quince seed.

Class XII. *Syrupi.* Syrups.

In making these the following is the proportion where no particulars are mentioned in respect to the weight of sugar.

Take of double-refined sugar twenty-nine ounces; any kind of liquor one pint, (one pint and a half, Dubl.); dissolve the sugar in the liquor, in a water bath; (mix and boil down to one pound, Dubl.); then set it aside for twenty-four hours; take off the scum, and pour off the syrup from the feces if there be any.

Syrups are solutions of sugar in any watery fluid, whether simple or medicated. Simple syrup is nutritious and demulcent. When made of fine sugar, it is transparent and colourless. If necessary, it is easily clarified by beating to a froth the white of an egg with three or four ounces of water, mixing it with the syrup, and boiling the mixture for a few seconds, until the albumen coagulates, and enveloping all heterogeneous matters, it forms a scum, which may be easily taken off, or separated by filtration. When, instead of simple water, any other fluid is used for dissolving the sugar, the syrup is then medicated. Medicated syrups are prepared either with express juices, infusions, decoctions, or saline fluids. The object of forming these into syrups is, either to render them agreeable to the palate, or to preserve them from fermentation. In the latter case, the quantity of sugar added becomes a matter of great importance; for if too much be employed, the sugar will separate by crystallization; and if too little, instead of preventing fermentation, it will accelerate it. About two parts of sugar to one of fluid, are the proportions directed by the British Colleges with this view. But as, in some instances, a larger quantity of fluid is added, and afterwards reduced to the proper quantity by decoction, it will not be superfluous to point out some circumstances which show the evaporation to have been carried far enough. These are, the tendency to form a pellicle on its surface, when a drop of it is allowed to cool; the receding of the last portion of each drop, when poured out drop by drop, after it is cold; and, what is most to be relied on, its specific gravity when boiling hot being about 1.385, or 1.3 when cold. The syrup which remains, after all the crystallizable sugar has been separated from it, has been much, and probably justly, recommended by some for the preparation of medicated syrups and electuaries, although its pharmaceutical superiority is actually owing to its impurity.

The following are the official preparations.

Syrupus simplex, Edin. simple syrup.

Syrupus acidi acetosi, Edin. syrup of acetous acid.

Syrupus allii, Dubl. syrup of garlic.

Syrupus altheæ, Lond. Edin. syrup of marshmallows.

Syrupus zingiberis, Lond. syrupus amomi zing Edin. syrup of ginger.

Syrupus corticis aurantii, Lond. syrupus citri aurantii, Edin. syrup of orange-peel.

Syrupus limonis succi, Lond. Dubl. syrupus citri medici, Edin. syrup of lemons.

Syrupus succi fructus mori, Dubl. syrupus succi fructus rub. idæi, Lond. syrup of mulberries.

Syrupus succi fructus ribis nigri, Lond. syrup of black currants.

Syrupus colchici autumnalis, Edin. syrup of colchicum.

Syrupus caryophylli rubri, Lond. syrupus dianthi caryophylli, Edin. syrup of clove July flowers.

Syrupus croci, Lond. syrup of saffron.

Syrupus mannæ, Dubl. syrup of manna.

Syrupus papaveris semniferi, Edin. syrupus papaveris albi, Lond. syrup of white poppies.

Syrupus papaveris erratici, Lond. syrup of red poppies.

Syrupus opii, Dubl. syrup of opium.

Syrupus rhamni cathartici, Edin. syrupus spinæ cervin, Lond. syrup of buckthorn.

Syrupus rosæ, Lond. syrupus rosæ centifoliæ, Edin. syrup of damask roses.

Syrupus rosæ Galliciæ, Edin. syrup of roses.

Syrupus scillæ maritimæ, Edin. syrup of squills.

Syrupus tolutanus, Lond. syrupus toluiferæ balsami, Edin. syrup of balsam of tolu.

Syrupus violæ, Lond. syrupus violæ odoratæ, Edin. syrup of violets.

Class XIII. *Mellita.* Medicated Honeys.

Honey itself is first to be despumated or clarified by dissolving it in a water-bath, and removing the scum as it arises. The following preparations are then made of it.

Mel. acetatum, Lond. honey acetated, simple oxymel.

Oxymel colchici, Lond. oxymel of meadow saffron.

Mel. rosæ, Lond. Dubl. honey of roses.

Mel. scillæ, Lond. honey of squills.

Oxymel scillæ, Lond. oxymel of squills.

Oxymel æruginis, Lond. oxymel of verdigris.

Class XIV. *Misturæ et Emulsiones.* Mixtures and Emulsions.

This double class comprehends preparations in which oils and other substances, insoluble in water, are mixed with, and suspended in, watery fluids, by means of such viscid substances as mucilages and syrups.

Emulsio amygdalæ communis, Edin. lac amygdalæ, Lond almond emulsion.

Emulsio arabiea, Edin. Dubl. gum arabic emulsion.

Emulsio camphorata, Edin. mistura camphorata, Lond. camphorated emulsion or mixture.

Lac ammoniaci, Lond. Dubl. emulsion of gum ammoniac.

Lac asæ fætidæ, Lond. emulsion of assafœtida.

Mistura moschata, Lond. musk mixture.

Mistura cretacea, Lond. chalk mixture.

Decoctum cornu cervi, Lond. decoction of hartshorn.

Class XV. *Aceta.* Medicated Vinegars.

Infusions of vegetable substances in acetic acid are commonly called medicated vinegars. The action of the acid in this case may be considered as twofold.

1. It acts simply as water, in consequence of the great quantity of water which enters into its composition, and generally extracts every thing which water is capable of extracting.

2. It exerts its own peculiar action as an acid. In consequence of this it sometimes increases the solvent power of its watery portion, or dissolves substances which water alone is incapable of dissolving, and in a few instances it impedes the solution of substances which water alone would dissolve.

As acetic acid, in itself sufficiently perishable, has its tendency to decomposion commonly increased by the solution of any vegetable matter in it, it should never be used as a menstruum, unless where it promotes the solution of the solvend, as in extracting the acrid principle of squills, colchicum, &c. and in dissolving the volatile, and especially the empyreumatic oils, or where it coincides with the virtues of the solvend.

Acetum aromaticum, Edin. aromatic vinegar, thieves vinegar.

Acetum colchici, Dubl. vinegar of meadow saffron.

Acetum scilliticum, Lond. acetum scillæ maritimæ, Edin. vinegar of squills

Acidum acetosum camphoratum, Edin. camphorated acetous acid.

CLASS XVI. *Tincturæ.* TINCTURES.

The term tincture has often been employed in a very vague sense. It is now commonly applied to coloured solutions, made by digestion, in alcohol, or diluted alcohol. But it is also, though perhaps incorrectly, extended to solutions in ether, ethereal spirits, and spirit of ammonia.

Alcohol is capable of dissolving resins, gum resins, extractive, tannin, sugar, volatile oils, soaps, camphor, adipocere, colouring matters, acids, alkalies, and some compound salts. Many of these, as the gum resins, soaps, extractive, tannin, sugar, and saline substances, are also soluble in water, while water is capable of dissolving substances, such as gum, gelatine, and most of the compound salts, which are insoluble in alcohol. But the insolubility of these substances, in the different menstrua, is not absolute, but merely relative; for a certain proportion of alcohol may be added to a solution of gum in water without decomposing it; and a solution of resin in alcohol will bear a certain admixture of water without becoming turbid. Therefore, diluted alcohol, which is a mixture of these two menstrua, sometimes extracts the virtues of heterogeneous compounds more completely than either of them separately.

Alcohol is used as a menstruum.

1. When the solvend is not soluble, or sparingly soluble, in water.

2. When a watery solution of the solvend is extremely perishable.

3. When the use of alcohol is indicated as well as that of the solvend.

In making alcoholic tinctures, we must observe, that the virtues of recent vegetable matters are very imperfectly extracted by spirituous menstrua. They must, therefore, be previously carefully dried, and as we cannot assist the solution by means of heat, we must facilitate it by reducing the solvend to a state of as minute mechanical division as possible. To prevent loss, the solution is commonly made in a close vessel, and the heat applied must be very gentle, lest it be broken by the expansion of vapour.

The action of tinctures on the living system is always compounded of the action of the menstruum, and of the matters dissolved in it. Now, these actions may either coincide with, or oppose, each other; and as alcohol is at all times a powerful agent, it is evident that no substance should be exhibited in the form of a tincture, whose action is different from that of alcohol, unless it be capable of operating in so small a dose, that the quantity of alcohol taken along with it is inconsiderable.

Tinctures are not liable to spoil, as it is called, but they must nevertheless be kept in well closed phials, especially when they contain active ingredients, to prevent the evaporation of the mentruum.

They generally operate in doses so small, that they are rarely exhibited by themselves, but commonly combined with some vehicle. In choosing the latter, we must select some substance which does not decompose the tincture, or at least separates nothing from it in a palpable form.

The London college direct all tinctures, except that of muriate of iron, to be prepared in closed phials.

The Dublin college explain, that, when they order substances to be digested, they mean it to be done with a low degree of heat; and when they are to be macerated, it is to be done with a degree of heat between 60° and 90°.

Tinctura aloes, Lond. tinctura succotorinæ, Edin. tincture of aloes

Tinctura aloes composita, Lond. tinctura aloes cum myrrha, Edin. tincture of aloes with myrrh.

Tinctura cardemomi, Lond. tinctura amomi repeutis, Edin. tincture of cardamoms.

Tinctura serpentariæ, Lond. tinctura aristolochiæ serpentariæ, Edin. tincture of snake-root.

Tinctura assæ fætidæ, Lond. Dubl. tincture of assafœtida.

Tinctura aurantii corticis, Lond. Dubl. tincture of orange-peel.

Tinctura balsami peruviani, Lond. tincture of balsam of Peru.

Tinctura benzoes composita, Lond. Edin. tincture of benjamin, compound.

Tinctura camphoræ, Edin. spiritus camphoratus, Lond. Dub. tincture of camphor, camphorated spirit.

In this the Edinburgh title is grossly inaccurate; the preparation being quite colourless instead of tinctured.

Tinctura cascarillæ, Lond. Dubl. tincture of cascarilla.

Tinctura sennæ, Lond. Dubl. tincture of senna.

Tinctura cassiæ sennæ composita, Edin. tincture of senna compound; elixir of health.

Tinctura castorei, Lond. Dub. tincture of castor.

Tinctura cinchonæ, Lond. Edin. tincture of Peruvian bark.

Tinctura cinchonæ composita, Lond.

Dubl. tincture of Peruvian bark, compound.

Tinctura columbæ, Lond. Edin. Dubl. tincture of Columbo.

Tinctura jalapæ, Lond. Dubl. tinctura convolvuli jalapæ, Edin. tincture of jalap.

Tinctura croci, Edin. tincture of saffron.

Tinctura digitalis purpureæ, Edin. tincture of foxglove.

Tinctura galbani, Lond. tincture of galbanum.

Tinctura gentianæ composita, Lond. Edin. tincture of gentian, compound.

Tinctura guaiaci, Edin. tincture of guaiacum.

Tinctura hellebori nigri, Lond. Dubl. tincture of black hellebore.

Tinctura hyosciami nigri, Edin. tincture of henbane.

Tinctura kino, Edin. Dubl. tincture of kino.

Tinctura cinnamomi, Lond. Dubl. tinctura lauri cinnamomi, Edin. tincture of cinnamon.

Tinctura lauri cinnamomi composita, Edin. Lond. tincture of cinnamon, compound.

Tinctura lavendula comp. Dubl. spiritus lavendulæ comp. Lond. spiritus lavendulæ spicæ comp. Edin. tincture of lavender, and spirit of lavender.

Here the Dublin title is wrong; the tincture is not derived from the lavender, but from the red saunders.

Tinctura cantharidis, Lond. Dubl. tinctura meloes vesicatorii, Edin. tincture of cantharides.

Tinctura misosæ catechu, Edin. tincture of catechu.

Tinctura moschi, Dubl. tincture of musk.

Tinctura myrrhæ, Lond. Edin. Dubl. tincture of myrrh.

Tinctura opii, Lond. Edin. Dubl. tincture of opium.

Tinctura opii camphorata, Lond. Dubl. tincture of opium camphorated.

Tinctura rhabarbari, Lond. Dubl. tinctura rhei palmati, Edin. tincture of rhubarb.

Tinctura rhabarbari composita, Lond. tincture of rhubarb, compound.

Tinctura rhei cum aloe, Edin. tincture of rhubarb with aloes.

Tinctura rhei cum gentiana, Edin. tincture of rhubarb with gentian.

Tinctura sabinæ composita, Lond. tincture of savin, compound.

Tinctura saponis, Edin. linimentum, saponis compositum, Lond. linimentum saponaceum, tincture of opodeldoc.

Tinctura saponis cum opio, Edin. anodyne liniment.

Tinctura scillæ, Lond. Dubl. tincture of squill.

Tinctura bals. tolutani, Lond. Dubl. tinctura toluiferæ balsamic, Edin. tincture of balsam of tolu.

Tinctura valerianæ, Lond. tincture of valerian.

Tinctura veratri albi, Edin. tincture of white hellebore.

Tinctura zingiberis, Lond. tincture of ginger.

Class XVII. *Ætherea.* Etherial Spirits.

Alcohol, alcohol.

Æther sulphuricus, Edin. æther vitriolicus, Lond. Dubl. sulphuric ether, vitriolic ether.

Æther sulphuricus cum alcohole, Edin. spiritus etheris vitriolici, Lond. spirit of ether.

Oleum vini, Lond. oil of wine.

Spiritus ætheris vitriolici comp. Lond. Hoffman's anodyne liquor.

Spiritus ætheris nitrosi, Lond. Edin. spirit of nitrous ether.

Linimentum camphoræ compositum, Lond. compound camphor liniment.

Linimentum volatile, Dubl. volatile liniment.

Alcohol ammoniatum aromaticum, Edin. spiritus ammoniæ compositus, Lond. sal volatile.

Spiritus ammoniæ succinatus, Lond. amber, spirit of ammonia, or eau de luce.

Tinctura castorei composita, Edin. compound tincture of castor.

Tinctura cinchonæ ammoniata, Lond. ammoniated tincture of cinchona.

Tinctura guaiaci ammoniata, Edin. Lond. tincture of guaiacum.

Tinctura opii ammoniata, Edin. tincture of opium.

Tinctura valerianæ ammonita, Lond. Dubl. tincture of valerian.

Class XVIII. *Vina.* Medicated Wines.

M. Parmentier has occupied thirty-two pages of the Annales de Chimie, to prove that wine is an extremely bad menstruum for extracting the virtues of medicinal substances. His argument, (for there is but one), is, that by the infusion of vegetable substances in wine, its natural tendency to decomposition is so much accelerated, that at the end of the process, instead of wine, we have only a liquor con-

taining the elements of bad vinegar. As a solvent, diluted alcohol perfectly supersedes the use of wine; and if we wish to use wine to cover the taste, or to assist the operation of any medicine, M. Parmentier proposes, that a tincture of the substance should be extemporaneously mixed with wine as a vehicle.

Notwithstanding this argument appears to us to have great weight, we shall allow to the medicated wines, retained in the pharmacopœias, the characters they still generally possess.

Vinum aloes, Lond. vinum aloes succotorinæ, Edin. wine of aloes.

Vinum gentianæ compositum, Edin. wine of gentian, compound.

Vinum ipecacuanhæ, Lond. Dubl. wine of ipecacuanha.

Vinum nicotianæ tabaci, Edin. wine of tobacco.

Vinum rhabarbari, Lond. vinum rhei palmati, Edin. wine of rhubarb.

The metallic wines have been noticed already.

Class XIX. *Extracta.* Extracts.

Extract, in pharmacy, has been long used, in the true and general sense of the term, to express a substance extracted from bodies of all kinds, by the action of whatever menstruum, and reduced to spissitude by the evaporation of that menstruum. Of late, however, it has been employed in a different and more limited sense, as the name for a peculiar principle, which is often, indeed, contained in extracts, and which before had no proper appellation. It is in the former sense that we employ it here, and in which we wish it to be only used, while a new word should be invented as the name of the new substance. Till a better be proposed we shall call it extractive.

Extracts are of various kinds, according to the nature of the substances from which they are obtained, and the menstruum employed; but they commonly consist of gum, sugar, extractive, tannin, gallic acid, or resin, or several of them mixed in various proportions. The menstrua most commonly employed are water and alcohol. The former is capable of extracting all the substances enumerated, except the resin, and the latter all except the gum. Wine is also sometimes employed, but very improperly; for as a solvent it can only act as a mixture of alcohol and water, and the principles which it leaves behind on evaporation are rather injurious than of advantage to the extract.

Water is the menstruum most economically employed in making extracts, as it is capable of dissolving all the active principles except resin, and can have its solvent powers assisted by a considerable degree of heat.

Watery extracts are prepared by boiling the subject in water, and evaporating the strained decoction to a thick consistence.

It is indifferent, with regard to the medicine, whether the subject be used fresh or dry; since nothing that can be preserved in this process will be lost by drying. With regard to the facility of extraction, there is a very considerable difference; vegetables in general giving out their virtues more readily when moderately dried than when fresh.

Very compact dry substances should be reduced into exceedingly small parts, previous to the affusion of the menstruum.

The quantity of water ought to be no greater than is necessary for extracting the virtues of the subject. This point, however, is not very easily ascertained; for although some of the common principles of extracts be soluble in a very small proportion of water, there are others, such as the tannin, of which water can dissolve only a certain proportion, and cannot be made to take up more by any length of boiling, and we have no very good method of knowing when we have used a sufficient quantity of water; for vegetable substances will continue to colour deeply successive portions of water boiled with them, long after they are yielding nothing to it but colouring matter. Perhaps one of the best methods is, to boil the subject in successive quantities of water, as long as the decoction forms a considerable precipitate with the test which is proper for detecting the substance we are extracting, such as a solution of gelatine for tannin, of alum for extractive, &c.

"The decoctions are to be depurated by colature; and afterwards suffered to stand for a day or two, when a considerable quantity of sediment is usually found at the bottom. If the liquor poured off clear be boiled down a little, and afterwards suffered to cool again, it will deposit a fresh sediment, from which it may be decanted before you proceed to finish the evaporation. The decoctions of very resinous substances do not require this treatment, and are rather injured by it; the resin subsiding along with the inactive dregs."

Such are the directions given in most of Dr. Duncan's editions of the New Edinburgh Dispensatory, for the depuration of the decoctions, and we have inserted them at full length, because, although we doubt very much of their propriety, our reasons for so doing are scarcely more than hypothetical. We would advise the decoctions to be evaporated after they have been filtered boiling hot, without any further depuration; because some of the most active principles of vegetable substances, such as tannin, are much more soluble in boiling than in cold water, and because almost all of them are very quickly affected by exposure to the atmosphere. Therefore, if a boiling decoction, saturated with tannin, be allowed to cool, the greatest part of the very principle on which the activity of the substance depends will separate to the bottom, and according to the above directions, will be thrown away as sediment. The same objection applies more strongly to allowing the decoction to cool, and deposit a fresh sediment, after it has been partially evaporated. Besides, by allowing the decoctions to stand several days before we proceed to their evaporation, we are in fact allowing the active principles contained in the decoction to be altered by the action of the air, and to be converted into substances, perhaps inactive, which also are thrown away as sediment.

The evaporation is most conveniently performed in broad shallow vessels: the larger the surface of the liquor, the sooner will the aqueous parts exhale. This effect may likewise be promoted by agitation.

When the matter begins to grow thick, great care is necessary to prevent its burning. This accident, almost unavoidable if the quantity be large, and the fire applied as usual under the evaporating pan, may be effectually prevented, by carrying on the inspissation, after the common manner, no further than the consistence of a syrup, when the matter is to be poured into shallow tin or earthen pans, and placed in an oven, with its door open, moderately heated; which acting uniformly on every part of the liquid, will soon reduce it to any degree of consistence required. This may likewise be done, and more securely, by setting the evaporating vessel in boiling water: but the evaporation is in this way very tedious.

Alcohol is much too expensive to be employed as a menstruum for obtaining extracts, except in those cases where water is totally inadequate to the purpose. The cases are, 1. When the nature of the extract is very perishable when dissolved in water, so that it is liable to be decomposed before the evaporation can be completed, especially if we cannot proceed immediately to the evaporation. 2. When water is totally incapable of dissolving the substance to be extracted; and, 3. When the substance extracted can bear the heat of boiling alcohol without being evaporated, but would be dissipated by that of boiling water; that is, when it requires a heat greater than 176°, and less than 212°, for its vaporization.

In the last case, the alcohol must be perfectly free from water, because the heat necessary to evaporate it at the end of the process would frustrate the whole operation. Hence, also, the subject itself ought always to be dry: those substances which lose their virtue by drying, lose it equally on being submitted to this treatment with the purest alcohol.

In this way the alcoholic extract of some aromatic substances, as cinnamon, lavender, rosemary, retain a considerable degree of their fine flavour. In the second case, the alcohol need not be so very strong, because it is still capable of dissolving resinous substances, although diluted with a considerable proportion of water. In the first case, the alcohol may be still much weaker: or rather, the addition of a small proportion of alcohol to water will be sufficient to retard or prevent the decomposition of the decoction.

The alcohol employed in all these cases should be perfectly free from any unpleasant flavour, lest it be communicated to the extract.

The inspissation should be performed from the beginning, in the gentle heat of a water-bath. We need not suffer the alcohol to evaporate in the air: the greatest part of it may be recovered by collecting the vapour in common distilling vessels. If the distilled spirit be found to have brought over any flavour from the subject, it may be advantageously reserved for the same purpose again.

When diluted alcohol is employed, the distillation should only be continued as long as alcohol comes over; and the evaporation should be finished in wide open vessels.

Pure resins are prepared by adding to spiritous tinctures of resinous vegetables

a large quantity of water. The resin, incapable of remaining dissolved in the watery liquor, separates and falls to the bottom, leaving in the menstruum such other principles of the plant as the spirit might have extracted at first along with it. But this is only practised for the purpose of analysis.

Extracts made with Water only.

Extractum gentianæ luteæ, Edin. extract of gentian. Having cut and bruised any quantity of gentian, pour upon it eight times its quantity of water. Boil to the consumption of one half of the liquor, and strain it by strong expression. Evaporate the decoction immediately to the consistence of thick honey, in a bath of water saturated with muriate of soda.

In the same manner are prepared extracts

Of the roots of liquorice, extractum glycyrrhizæ glabræ.

Of the roots of black hellebore, extractum hellebori nigri.

Of the leaves of rue, extractum rutæ graveolentis.

Of the leaves of senna, extractum cassiæ sennæ.

Of the flowers of camomile, extractum anthemidis nobilis (chamœmeli.)

Of the heads of white poppy, extractum papaveris albi.

Of logwood, extractum hæmatoxyli Campechensis.

Extract of broom tops, extractum cacuminis genistæ.

Extract of camomile, extractum chamæmeli.

Extract of savin, extractum sabinæ.

The other extracts of this division are,

Extractum cinchonæ, Lond. extract of Peruvian bark.

Extractum hæmatoxyli, Lond. extract of logwood.

Extractum opii, Dubl. extract of opium.

Extractum sennæ, Lond. extract of senna.

Extracts made with Alcohol and Water.

Extractum cinchonæ officinalis, Edin. extractum cinchonæ cum resina, Lond. resin of bark.

Extractum radicis convolvuli jalapæ, Edin. extractum jalapii, Lond. resin of jalap.

Extractum cascarillæ, Lond. resin of cascarilla.

Extractum colocynthidis compositum, compound extract of colocynth.

Class XX. *Pulveris.* Powders.

This form is proper for such materials only as are capable of being sufficiently dried to become pulverisable without the loss of their virtue. There are several substances, however, of this kind, which cannot be conveniently taken in powder; bitter, acrid, fœtid drugs are too disagreeable; emollient and mucilaginous herbs and roots are too bulky; pure gums cohere, and become tenacious in the mouth: fixed alkaline salts deliquesce when exposed to the air, and volatile alkalies exhale. Many of the aromatics, too, suffer a great loss of their odorous principles when kept in powder; as in that form they expose a much larger surface to the air.

The dose of powders, in extemporaneous prescription, is generally about half a drachm: it rarely exceeds a whole drachm; and is not often less than a scruple. Substances which produce powerful effects in smaller doses are not trusted to this form, unless their bulk be increased by additions of less efficacy; those which require to be given in larger ones are better fitted for other forms.

The usual vehicle for taking the lighter powders, is any agreeable thin liquid. The ponderous powders, particularly those prepared from metallic substances, require a more consistent vehicle, as syrups; for from thin ones they soon subside; resinous substances likewise are most commodiously taken in thick liquors, for in thin ones they are apt to run into lumps, which are not easily again soluble.

Pulvis aloes cum canella, Lond. powder of aloes with canella.

Pulvis aloeticus cum guaiaco, Lond. powder aloetic with guaiacum.

Pulvis aloeticus cum ferro, Lond. powder aloetic with iron.

Pulvis aromaticus, Lond. Dubl. powder aromatic.

Pulvis asari compositus, Lond. Dubl. powder of asarabacca compound.

Pulvis cretæ compositus, Lond. pulvis carbonatis calcis comp. Edin. powder of chalk, compound.

Pulvis cretæ compositus cum opio, Lond. powder of chalk, compound with opium.

Pulvis chelarum cancri compositus, Lond. powder of crab's claws, compound.

Pulvis cerussæ compositus, Lond. powder of ceruse, compound.

Pulvis contrayervæ comp. Lond. powder of contrayerva, compound.

Pulvis ipecacuanhæ comp. Lond. pulvis ipecacuanhæ et opii. Edin. powder of Dover's.

Pulvis myrrhæ comp. Lond. powder of myrrh compound.

Pulvis scammonii comp. Lond. Edin. Dubl. powder of scammony, compound.

Pulvis scammonii comp. cum aloe, Lond. powder of scammony compound with aloes.

Pulvis scammonii comp. cum calomelane, Lond. powder of scammony with calomel.

Pulvis senæ compositus, Lond. powder of senna, compound.

Pulvis sulphatis aluminæ comp. Edin. powder of styptic.

Pulvis tragacanthæ compositus, Lond. powder of tragacanth, compound.

Class XXI. *Confectiones.* Confections.

Under this head we include all those preparations which have hitherto been loosely denominated conserves, electuaries, and confections; the difference in the preparation of which being too trifling for distinct heads.

Confections are, for the most part, compositions of recent vegetable matters and sugars, beaten or otherwise mixed together into an uniform mass. The sugar should be pounded by itself, and passed through a sieve before it be mixed with the vegetable mass, for without this it cannot be properly incorporated. It is obvious that, from the large admixture of sugar, only substances of considerable activity can be taken with advantage in this form. Conserves are hence, for the most part, only auxiliary to medicines of greater activity; as, for example, for reducing into boluses or pills the more ponderous powders, as calomel, oxides of iron, and other mineral preparations.

Electuaries are composed chiefly of powders mixed up with syrups, &c. into such a consistence, that the powders may not separate in keeping, that a dose may be easily taken up on the point of a knife, and not prove too stiff to swallow.

Electuaries receive chiefly the milder alterative medicines, and such as are not ungrateful to the palate. The more powerful drugs, as cathartics, emetics, opiates, and the like (except in officinal electuaries to be dispensed by weight), are seldom trusted in this form, on account of the uncertainty of the dose: disgustful ones, acrids, bitters, fœtids, cannot be conveniently taken in it; nor is the form of an electuary well fitted for the more ponderous substances, as mercurials, these being apt to subside on keeping, unless the composition be made very stiff.

The lighter powders require thrice their weight of honey, or syrup boiled to the thickness of honey, to make them into the consistence of an electuary: of syrups of the common consistence, twice the weight of the powder is sufficient.

Where the common syrups are employed, it is necessary to add likewise a little conserve, to prevent the compound from candying and drying too soon. Electuaries of Peruvian bark, for instance, made up with syrup alone, will often, in a day or two, grow too dry for taking.

This is owing to the crystallization of the sugar. Deyeux, therefore, advises electuaries, confections, and conserves, to be made up with syrups from which all the crystallizable parts have been separated. For this purpose, after being sufficiently evaporated, they are to be exposed to the heat of a stove as long as they form any crystals. The syrup which remains, probably from the presence of some vegetable acid, has no tendency to crystallize, and is to be decanted and evaporated to a proper consistence. In hospital practice, the same object may be obtained much more easily by using molasses instead of syrups.

The quantity of an electuary directed at a time, in extemporaneous prescription, varies much, according to its constituent parts, but is rarely less than the size of a nutmeg, or more than two or three ounces.

The conservæ are,

Citri aurantii, Edin. aur. hispalensis, Lond. conserve of orange peel.

Rosæ caninæ, Edin. cynosbati, Lond. conserve of hips.

Rosæ rubræ, Edin. Lond. rosæ, Dubl. conserve of red rose buds.

Lujulæ, Lond. acetosellæ, Dubl. conserve of wood sorrel.

Pluck the leaves from the stalks, the unblown petals from the cups, taking off the heels. Take the outer rind off the oranges by a grater.

When prepared in this way, beat them with a wooden pestle in a marble mortar, first by themselves, afterwards with three times their weight of double refined sugar, until they be mixed.

The only exceptions to these general directions, which are those of the London college, are, that the London college adds

only twenty ounces of sugar to one pound of the pulp of hips, and that the Dublin add only twice their weight of sugar to the sorrel leaves. La Grange says, that by infusing the red rose leaves in four times their weight of water, which is afterwards to be expressed from them, they lose their bitterness, and are more easily reduced to a pulp, which he then mixes with a thick syrup, prepared by dissolving the sugar in the expressed liquor, and boiling it down to the consistence of an electuary.

It is scarcely necessary to make any particular remarks on these conserves. Their taste and virtues are compounded of those of sugar, and the substance combined with it. The wood sorrel and hips are acidulous and refrigerant; the orange rind and worm-wood bitter and stomachic, and the red rose buds astringent.

The electuaries and confections are as follow:

Flectuarium cassiæ, Lond. Dubl. electuarium cassiæ fistulæ, Edin. electuary of cassia.

Electuarium cassiæsennæ, Edin. electuarium sennæ, Lond electuary lenitive.

Electuarium catechu, Edin. electuary of catechu.

Electuarium catechu comp. Dubl. electuary of catechu, compound.

Electuarium scammonii, Lond. Dubl. electuary of scammony.

Electuarium opiatum, Edin. confectio opiata, Lond. electuary of opium, opiate confection.

Confectio aromatica, Lond. aromatic confection.

Class XXII. *Trochisci*. Troches.

Troches and lozenges are composed of powders made up with glutinous substances into little cakes, and afterwards dried. This form is principally made use of for the more commodious exhibition of certain medicines, by fitting them to dissolve slowly in the mouth, so as to pass by degrees into the stomach; and hence these preparations have generally a considerable proportion of sugar or other materials grateful to the palate. Some powders have likewise been reduced into troches, with a view to their preservation; though possibly for no very good reasons; for the moistening, and afterwards drying them in the air, must in this light be of greater injury than any advantage accruing from this form can counterbalance.

Trochisci cretæ, Lond. trochisci carbonatis calcis, Edin. troches of chalk.

Trochisci glycirrhizæ, Lond. Dubl. troches of liquorice.

Trochisci glycirrhizæ cum opio, Edin. Dubl. troches of liquorice with opium.

Trochisci amyli, Lond, troches of starch.

Trochisci gummosi, Edin. troches of starch with gum arabic.

Trochisci magnesiæ, Lond, troches of magnesia.

Trochisci nitri, Lond. trochisci nitratis potassæ, Edin. troches of nitre.

Trochisci sulphuris, Lond. troches of sulphur.

Class XXIII. *Pilulæ*. Pills.

The masses for pills are best kept in bladders, which should be moistened now and then with some of the same kind of liquid that the mass was made up with, or with some proper aromatic oil. When the mass is to be divided into pills, a given weight of it is rolled out into a cylinder of a given length, and of an equal thickness throughout, and is then divided into a given number of equal pieces, by means of a simple machine. These pieces are then rounded between the fingers; and, to prevent them from adhering, they are covered either with starch, or powder of liquorice, or orris root. In Germany the powder of lycopodium is much used.

To this form are peculiarly adapted those drugs which operate in a small dose, and whose nauseous and offensive taste or smell require them to be concealed from the palate.

Pills should have the consistence of a firm paste, a round form, and a weight not exceeding five grains. Essential oils may enter them in small quantity: deliquescent salts are improper. Efflorescent salts, such as carbonate of soda, should be previously exposed so as to fall to powder: deliquescent extracts should have some powder combined with them. The mass should be beaten until it become perfectly uniform and plastic. Powders may be made into pills with extracts, balsams, soap, mucilages, bread-crumb, &c.

Gummy resins, and inspissated juices, are sometimes soft enough to be made into pills, without addition: where any moisture is requisite, spirit of wine is more proper than syrups or conserves, as it unites more readily with them, and does not sensibly increase their bulk. Light dry powders require syrup or mu-

cilages: and the more ponderous, as the mercurial and other metallic preparations, thick honey, conserve, or extracts.

Light powders require about half their weight of syrup; or of honey, about three fourths their weight: to reduce them into a due consistence for forming pills. Half a drachm of the mass will make five or six pills of a moderate size.

Gums and inspissated juices are to be first softened with the liquid prescribed: the powders are then to be added, and the whole beat thoroughly together, till they be perfectly mixed.

Pilulæ aloeticæ, Edin. Dubl. pills aloetic.

Pilulæ aloes compositæ, Lond. pills aloetic, compound.

Pilulæ aloes cum assafœtida, Edin. pills aloetic with assafœtida.

Pilulæ aloes cum colocynthide, Edin. pills aloetic with colocynth.

Pilulæ aloes cum myrrha, Lond. pills aloetic with myrrh.

Pilulæ assafœtida compositæ, Edin. pills of assafœtida, compound.

Pilulæ galbani compositæ, Lond. pills of galbanum, compound.

Pilulæ ammoniareti cupri, Edin. pills of ammoniaret of copper.

Pilulæ hydrargyri, Lond. Edin. Dubl. pills of quicksilver.

Pilulæ opii, Lond. pilulæ opiatæ, Edin. pills of opium.

Pilulæ rhei compositæ, Edin. pills of rhubarb, compound.

Pilulæ scillæ, Lond. Dubl. Edin. pills of squills.

Pilulæ stibii compositæ, Dubl. pills of antimony, compound; Plummer's.

The common mercurial pill is one of the best preparations of mercury, and may, in general, supersede most other forms of this medicine. In its preparation the mercury is minutely divided, and probably converted into the black oxide. To effect its mechanical division it must be triturated with some viscid substance. Soap, resin of guaiac, honey, extract of liquorice, manna, and conserve of roses, have all been at different times recommended. The soap and guaiac have been rejected, on account of their being decomposed by the juices of the stomach; and the honey, because it was apt to gripe some people. With regard to the others, the grounds of selection are not well understood; perhaps the acid contained in the conserve of roses may contribute to the extinction of the mercury. We learn when the mercury is completely extinguished, most easily, by rubbing a very little of the mass with the point of the finger on a piece of paper, if no globules appear. As soon as this is the case, it is necessary to mix with the mass a proportion of some dry powder, to give it a proper degree of consistency. For this purpose powder of liquorice root has been commonly used; but it is extremely apt to become mouldy, and to cause the pills to spoil. The Edinburgh College have, therefore, with great propriety, substituted for it starch, which is a very inalterable substance, and easily procured at all times in a state of purity. It is necessary to form the mass into pills immediately, as it soon becomes hard. One grain of mercury is contained in four grains of the Edinburgh mass, in three of the London, and in two and a half of the Dublin. The dose of these pills must be regulated by circumstances; from two to six five-grain pills may be given daily.

Class XXIV. *Cataplasmata.* Cataplasms.

By cataplasms are generally understood those external applications which are brought to a due consistence or form for being properly applied, not by means of oily or fatty matters, but by water or watery fluids. Of these many are had recourse to in actual practice; but they are seldom prepared in the shops of the apothecaries, and in some of the best modern Pharmacopœias no formula of this kind is introduced. The London and Dublin Colleges, however, although they have abridged the number of cataplasms, still retain a few; and it is not without some advantage that there are fixed forms for the preparation of them.

Cataplasma aluminis, Lond. Coagulum aluminis, Dubl. cataplasm of alum, alum curd.

Cataplasma cumini, Lond. cataplasm of cummin, London treacle.

Cataplasma sinapeos, Lond. Dubl. cataplasm of mustard.

Cataplasms of mustard are commonly known by the name of sinapisms. They were formerly frequently prepared in a more complicated state, containing garlick, black soap, and other similar articles; but the above simple form will answer every purpose which they are capable of accomplishing. They are employed only as stimulants: they often inflame the part and raise blisters, but not so perfectly as cantharides. They are frequently applied to the soles of the feet in the low state of acute diseases, for raising the

pulse and relieving the head. The chief advantage they have depends on the suddenness of their action.

CLASS. XXV. *Linimenta.* LINIMENTS.

CLASS XXVI. *Unguenta.* OINTMENT.

CLASS XXVII. *Cerata.* CERATES.

CLASS XXVIII. *Emplastra.* PLASTERS.

We connect these together, as being all oleaginous or fatty combinations for external application, and as merely differing from each other in their degree of consistency. Deyeux has, indeed, lately defined plasters to be combinations of oil with metallic oxides; but as this would comprehend many of our present ointments, and exclude many of our plasters, we shall adhere to the old meaning of the terms.

Liniments are the thinnest of these compositions, being only a little thicker than oil.

Ointments have generally a degree of consistence like that of butter.

Cerates are firmer, and contain a larger proportion of wax.

Plasters are the most solid, and when cold should be firm, and not adhere to the fingers; but when gently heated should become sufficiently soft to spread easily, and should then adhere to the skin. Plasters derive their firmness either from a large proportion of wax, resin, &c. or from the presence of some metallic oxide, such as that of lead.

Plasters should have such a consistence, that although when cold they do not adhere to the fingers, they become soft and plastic when gently heated. The heat of the body should render it tenacious enough to adhere to the skin, and to the substance on which it is spread. When prepared, it is usually formed into rolls, and inclosed in paper. Plasters of a small size are often spread on leather, sometimes on strong paper, by means of a spatula gently heated, or the thumb. The leather is cut of the shape wanted, but somewhat larger; and the margin all round, about a quarter of an inch in breadth, is left uncovered, for its more easy removal when necessary. Linen is also often used, especially for the less active plasters, which are used as dressings, and often renewed. It is generally cut into long slips of various breadths, from one to six inches. These may either be dipped into the melted plaster, and passed through two pieces of straight and smooth wood, held firmly together, so as to remove any excess of plaster; or, what is more elegant, they are spread on one side only, by stretching the linen, and applying the plaster, which has been melted and allowed to become almost cold, evenly by means of a spatula, gently heated, or, more accurately, by passing the linen on which the plaster has been laid, through a machine formed of a spatula fixed, by screws, at a proper distance from a plate of polished steel.

To prevent repetition, the Edinburgh College give the following canon for the preparation of these substances:

"In making these compositions, the fatty and resinous substances are to be melted with a gentle heat, and then constantly stirred; adding, at the same time, the dry ingredients, if there be any, until the mixture, on cooling, becomes stiff."

Linimentum simplex, Edin. simple liniment, wax and oil.

Oleum ammoniatum, Edin. linimentum ammoniæ, Lond. oil or liniment of ammonia, volatile liniment.

Linimentum ammoniæ fortius, Lond. volatile liniment, stronger.

Oleum lini cum calce, Edin. linseed oil with lime.

Oleum camphorat. Ed. camphorated oil.

Unguentum adipis suillæ, Lond. ointment of hogs' lard.

Unguentum simplex, Edin. ointment of simple wax and oil.

Unguentum spermatis ceti, Lond. Dubl. ointment of spermaceti.

Unguentum ceræ, Lond. Dubl. ointment of wax.

Unguentum acidi nitrosi, Edin. ointment of nitrous acid.

Unguentum resinæ flavæ, Lond. Dubl. ointment of yellow resin.

Unguentum elemi, Dubl. unguentum elemi compositum, Lond. ointment of elemi.

Unguentum picis, Lond. Dubl. ointment of tar.

Unguentum sambuci, Lond. Dubl. ointment of elder.

Unguentum cantharidis, Lond. Dubl. ointment of cantharides.

Unguentum infusi meloes vesicatorii, Edin. ointment of mild epispastic.

Unguentum pulveris meloes vesicatorii, Edin. ointment of stronger epispastic.

Unguentum hellebori albi, Lond. Dubl. ointment of white hellebore.

Unguentum sulphuris, Lond. Dubl. ointment of sulphur.

Unguentum oxidi plumbi albi, Edin. ointment of oxide of white lead.

Unguentum acetitis plumbi, Edin. the acetite of lead, saturnine ointment.

Unguentum cerussæ acetatæ, Lond. Dubl. ointment of acetated ceruse.

Unguentum hydrargyri, Edin. ointment of quicksilver.

Unguentum hydrargyri fortius, Lond. Dubl. ointment of quicksilver, stronger.

Unguentum hydrargyri mitius, Lond. Dubl. ointment of quicksilver, milder.

Unguentum calcis hydrargyri albi, Lond. ointment of white precipitate.

Unguentum calcis hydrargyri rubri, Lond. ointment of red precipitate.

Unguentum nitratis hydrargyri, Edin. citrine ointment.

Unguentum subacititis cupri, Edin. ointment of verdigris.

Unguentum oxidi zinci impuri, unguentum tutiæ, Lond. Dubl. ointment of tutty.

Unguentum oxidi zinci, Edin. ointment of oxide of zinc.

Ceratum simplex, Edin. ceratum spermatis ceti, Lond. Dubl. cerate of spermaceti.

Ceratum resinæ flavæ, Lond. Dubl. cerate of yellow resin.

Ceratum cantharidis, Lond. Dubl. cerate of cantharides.

Ceratum saponis, Lond. Dubl. cerate of soap.

Ceratum lithargyri acetati compositum, Lond. saturnine cerate.

Ceratum carbonatis zinci impuri, Edin. cerate of carbonate of zinc.

Ceratum lapidis calaminaris, Lond. Dubl. cerate of calamine epulotic, Turner's.

Emplastrum ceræ, Dubl. emplastrum ceræ compositum, Lond. emplastrum simplex, Edin. plaster of wax, drawing.

Emplastrum picis Burgundicæ, Dubl. emplastrum picis Burgundicæ composit. Lond. plaster of Burgundy pitch.

Emplastrum cumini, Lond. plaster of cummin.

Emplastrum ladani compositum, plaster of laudanum compound.

Emplastrum cantharidis, Lond. Dubl. emplastrum meloes vesicatorii, Edin. plaster of canthrides.

Emplastrum meloes vesicatorii composit. Edin. plaster of cantharides, compound.

Emplastrum oxidi plumbi semivitrei, Edin. emplastrum lithargyri, plaster of common litharge.

Emplastrum resinorum, Edin. emplastrum lithargyri cum resina, Lond. plaster, adhesive.

Emplastrum assafœtida, Edin. emplastrum gummosum, Lond. plaster of gum or assafœtida.

Emplastrum lithargyri compositum, Lond. plaster of litharge, compound.

Emplastrum saponis, Dubl. emplastrum saponaceum, Lond. Edin. plaster of soap.

Emplastrum thuris compositum, Lond. plaster of frankincense, compound.

Emplastrum hydrargyri, Edin. plaster of quicksilver.

Emplastrum ammoniaci cum hydrargyro, Lond. plaster of gum ammoniac with quicksilver.

Emplastrum lithargyri cum hydrargyro, Lond. plaster of litharge with quicksilver.

Emplastrum oxidi ferri rubri, Edin. plaster of red oxide of iron.

We shall close this article by observing, that the adult dose of the different preparations, and materials of which they are composed, will, for the most part, be found in the article Materia Medica.

Since writing the above we have received a copy of a specimen just printed, and limitedly circulated by the London College of Physicians, as the groundwork of a new Pharmacopœia, which it is their intention to bring forward as soon as they may be able to avail themselves of the various hints and suggestions which it is probable will result from a circulation of their present pamphlet. As this is a work of high consequence to the medical world, and of curiosity to those who have not had an opportunity of seeing the specimen before us, and more especially as we are persuaded that the Royal College, with its usual liberality, will receive with thanks any important information upon the subject in question, from whatever quarter it may proceed; we shall endeavour as concisely as possible to sketch an outline of the valuable labours in which they are engaged, from the specimen before us: which we cannot better commence than in the words of the Committee, to whom the College has chiefly submitted the undertaking.

In the progression of human knowledge, pharmacy cannot remain stationary, and the College have accordingly accommodated it to existing circumstances, at suitable intervals, and thereby regulated and improved the practice of medicine in this country. Such a revision they have

felt themselves called upon to make, at the present time, by the vast improvement in the several branches of science, with which pharmacy is more especially connected, since the year 1787, and they think it proper to state, generally, the principles upon which various alterations have been adopted in the present instance.

These alterations are referable to the several heads of nomenclature, weights and measures, arrangement, processes, the omission of former articles, and the introduction of new ones.

To each of these it will apply as a general observation, that practical application and convenience have been assumed as fundamental points, which the Committee have endeavoured constantly to keep in view.

1. *Nomenclature.* At the time of the publication of the last Pharmacopœia, modern chemistry was in its infancy, its language, (which professed to describe, and not merely to designate a substance by its name) was new in principle, and the application of it not generally received. Various terms, therefore, of that Pharmacopœia differ essentially from those which have since been established in the science, and it has been incumbent upon the Committee to consider, in the present instance, whether the nomenclature of chemistry might be still further and more minutely adopted. As far as arbitary names (to which common consent has affixed precise ideas) go, and also in compounds consisting of two ingredients only, or where different portions of the same constituent parts are to be expressed, it has been thought proper to receive those terms which general chemistry employs; but as a large proportion of pharmaceutical preparations consist, strictly speaking, of more complex combinations, which cannot be expressed correctly without periphrasis and inconvenience, and are therefore but ill suited to the purposes of perscription, the Committee have judged it sufficient to designate these, without attempting at the same time to describe their composition; and whether the name has been drawn from some circumstance of preparation, or quality, they have cautiously endeavoured to make such distinctions as may be least liable to error in the ordinary method of practice, and may not contradict the received chemical doctrines, or mislead in their application.

The names of vegetables have also been accommodated to the latest systems of botany, so that they may not hereafter contradict the terms of that science, or deceive the practicioner in his references thereto. Many names of medicinal plants were in the earlier periods of botany drawn from those of families to which modern system does not admit them to belong*, but have been retained in pharmacy, though wholly at variance with the improved state of science. The Committee trust they have been able to remedy this inconvenience, without very frequent violence to the names commonly employed. They have thought it most convenient, and fully sufficient, to express each article in general by a single word†, and have retained the former one wherever it accorded either with the generic or specific name of Linnæus, both of which, however, it has been necessary to employ, for the purpose of distinguishing between them, when more than one species is taken from the same genus‡. There being some vegetable substances, the names of which are in a manner independent of botanical nomenclature§, no alteration with respect to these seemed necessary, for in fact they are not at variance with modern science. Intending, moreover, that the pharmaceutic name shall, where a part of a plant is used, refer to that part only, they have transferred the term expressive of such part from the first column of the catalogue, in which it formerly stood, to the second.

2. *Weights and Measures.* From the great uncertainty of the customary mode of dividing by drops any quantities of liquids of less bulk than a drachm, and the increase of that uncertainty by the late introduction, into some shops, of measures applying to liquids of different densities, the bulk of a drop of water as a standard, the Committee have been led to consider the subject more particularly, and to adopt means for the removal of this uncertainty in the exhibition of many active remedies for the future. They have, for this purpose, adopted the graduated measure of the late Mr. Lane, which is founded upon an accurate division of the exchequer wine gallon down to the one-sixtieth part of a drachm, and which is equivalent to a drop of water. Of course it is their intention, that the common method of dropping liquids of

* *Cicuta, Helleborus albus.*

† *Aconitum. Cascarilla.*

‡ *Rosa Gallica. Rosa canina.*

§ *Arabicum gummi.*

different densities should be disused, and the measure received into the shops of apothecaries, a point upon which it will be necessary to place especial stress, in order that prescriptions may be accurately prepared. As the same Latin term has been employed to express the pint measure and the pound weight, they have extended the same resemblance to inferior measures, and have the more readily substituted *granum* for *gutta*, because the latter term implies that peculiar mode of division which they wish to deprecate.

3. *Arrangement.* On this head it is only necessary to observe, that the chapters have been arranged in what appeared to be a more natural and convenient order of the substances concerned than the former one.

4. *Processes.* Considerable alteration has been made in various processes, by which it is hoped they will be found more accommodated to general use. Expense in preparation ought not to be balanced against correctness and uniformity, and it is to be lamented that the profits and competition of trade should have induced a very extensive disposition to deviate from the directions of the Pharmacopœia. To this point, therefore, the Committee have looked with much attention, and, as far as they have thought themselves justified they have endeavoured to make such deviation less an object to the operating chemist than heretofore; for this purpose they have not looked in their formulæ to that accuracy which would be necessary for chemical tests, but rather to the uniformity of the preparation, and its use as a medicine. The directions for manipulation are given generally, because they admit of some variety in their application in many instances, according to the scale on which they are prepared, and other circumstances; the Committee trust, however, that, if their directions be followed, the results will be in the same proportion uniform and correct, and that the well educated apothecary will have no difficulty in understanding and applying them. Under this head, it is particularly incumbent upon the Committee to acknowledge the great advantage they have derived from the liberal communications of the Society of Apothecaries, with respect to the practice of their extensive concern, and also from many individuals engaged in chemical preparations upon a large scale.

5. *Omission of former Articles, and Introduction of new ones.* In the rejection of many substances of trifling importance or efficacy, of others which have appeared rather to belong to extemporaneous prescription, and of certain forms of medicine which have become obsolete in general practice, and also in the introduction of any new articles, the Committee have exercised their own judgment freely, and they trust with sufficient caution. They hope the College at large will approve of their having neglected to insert many substances which individual practitioners have recommended and employed, where such have not received the sanction of more general experience. They conceive further, that a strict examination of its powers ought to precede the introduction of any article into the Pharmacopœia, and that the late appointment of a Committee of the College for this express purpose will hereafter appreciate the value of such recommendations by surer tests than those which have heretofore been deemed sufficient.

The proposed Materia Medica is as follows, in which it will be perceived that the vegetables are described, in the second column, from Wildenow's edition of the "Species Plantarum" of Linnæus; and the animals from Gmelin's "Systema Naturæ" of the same writer, excepting indeed in a very few instances. This table we cannot and ought not to abridge.

Absinthium	Artemisia Absinthium
Acetosa	Rumex Acetosa *Folium*
Acetosella	Oxalis Acetosella
Acetum	
Aconitum	Aconitum Napellus
Acidum sulphuricum	Acidum sulphuricum
Adeps	Sus Scrofa *Adeps*
Ærugo	Sub-Acetis Cupri
Allium	Allium sativum *Radix*
Aloe Barbadensis	Aloe elongata MURRAY, *Opusc. Botan.* *Succus spissata*
——socotorina	Aloe spicata *Succus spissatus*
Althææ Folium	Althæa officinalis
———Radix	Althæa officinalis
Alumen	Super-sulphas Aluminæ et Potassæ
Ammonia muriata	Murias Ammoniæ
Ammoniacum	*Plantæ adhuc incognitæ Gummi-resina*

Amygdala amara	Amygdalus communis. Var. γ
——— dulcis	Var. β *Nucleus*
Amylum	Triticum hybernum *Amylum*
Anethum	Anethum graveolens *Semen*
Augusturæ Cortex	*Arboris Americæ meridionalis adhuc incognitæ Cortex*
Anisum	Pimpinella Anisum *Semen*
Anthemis	Anthemis nobilis *Flos simplex*
Antimonium sulphuratum	Sulphuretum Antimonii
Arabicum Gummi	Acacia vera *Gummi*
Argentum	
Armoracia	Cochlearia Armoracia *Radix*
Arsenicum	Oxidum Arsenici album
Asarum	Asarum Europæum *Folium*
Assafœtida	Ferula Assafœtida *Gummi-resina*
Aurantium Hispalense	Citrus Aurantium (Hispalensis) *Bacca*
Aurantii Cortex	*Bacca Cortex exterior*
Balsamum Peruvianum	Myroxylon peruiferum *Balsamum*
——— Tolutanum	Toluifera Balsamum *Balsamum*
Barilla	Carbonas Sodæ impura
Belladonna	Atropa Belladonna *Folium*
Benzoin	Styrax Benzoin *Balsamum*
Bistorta	Polygonum Bistorta *Radix*
Borax	Sub-boras Sodæ
Cajuputi Oleum	Melaleuca Cajuputi *Oleum essentiale*
Calaminaris	Carbonas Zinci impura
Calamus	Acorus Calamus *Radix*
Cambogia	Stalagmitis Cambogioides *Gummi-resina*
Camphora	Laurus Camphora *Materia volatilis peculiaris*
Canella	Canella alba

	Cortex	
Capsicum	Capsicum annuum *Capsula*	
Carbo Ligni		
Cardamine	Cardamine pratensis *Flos.*	
Cardamomum	Alpinia repens Smith, in *Act. Soc. Lin.* *Semen*	
Carum	Carum Carui *Semen*	
Caryophyllus	Eugenia caryophyllata *Flos nondum expansus siccatus*	
Cariophylli Oleum	*Ejus oleum essentiale*	
Cascarilla	Croton Cascarilla *Cortex*	
Cassia Fistula	Cassia Fistula *Lomenti pulpa*	
Castoreum Rossicum	Castor Fiber *Materia peculiaris*	
Catechu	Acacia Catechu *Extractum*	
Centaurium	Chironia Centaurium *Cacumen*	
Cera alba ——— flava	Apis mellifica *Cera*	
Cerussa	Oxidum Plumbi album	
Cinchonæ Cortex	Cinchona lancifolia *Cortex*	
——— flavus	Cinchona cordifolia *Cortex*	Mutis.
——— ruber	Cinchona oblongifolia *Cortex*	
Cinnamomi Cortex	Laurus Cinnamomum *Cortex*	
——— Oleum	*Ejus oleum essentiale*	
Coccus	Coccus Cacti	
Colchicum	Colchicum autumnale *Radix recens*	
Colocynthis	Cucumis Colocynthis *Pomi pulpa*	
Colombo Radix	*Plantæ adhuc incognitæ Radix*	
Conium	Conium maculatum	
Contrajerva	Dorstenia Contrajerva *Radix*	
Copaiba	Copaifera officinalis *Resina liquida*	

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Coriandrum	Coriandrum sativum *Semen*
Cornu	Cervus Elaphas *Cornu*
Creta	Carbonas Calcis
Crocus Anglicus	Crocus stativus *Stigma*
Cuminum	Cuminum Cyminum *Semen*
Cuprum	
Cuprum Sulphuricum	Sulphas Cupri
Cydonia	Pyrus Cydonia *Semen*
Dauci Radix	Daucus Corota (hortensis) *Radix*
—— Semen	Daucus Corota (spontanea) *Semen*
Digitalis	Digitalis purpurea *Folium*
Dolichos	Dolichos pruriens *Leguminis pubes*
Dulcamara	Solanum Dulcamara *Caulis*
Elaterium	Momordica Elaterium *Pomum recens*
Elemi	Amyris Elemifera *Resina*
Ferrum	
Ficus	Ficus Carica *Fructus præparatus*
Filix Mas	Aspidium Filix Mas. *Radix*
Fœniculum	Anethum Fœniculum *Semen*
Fucus	Fucus vesiculosus
Galbanum	Bubon Galbanum *Gummi-resina*
Galla	Cynips Quercus folii *Nidus*
Gentiana	Gentiana lutea *Radix*
Glycyrrhiza	Glycyrrhiza glabra *Radix*
Granatum	Punica Granatum *Pomi Cortex*
Guaiaci Gummi-resina. ——— Lignum	Guaiacum officinale
Hæmatoxylon	Hæmatoxylon Campechianum *Lignum*
Helleborus fœtidus	Helleborus fœtidus *Folium*
Helleborus niger	Helleborus niger *Radix*
Hordeum	Hordeum distichon

	Semen epidermide nudatum
Humulus	Humulus Lupulus *Strobilus siccatus*
Hyoscyamus	Hyoscyamus niger
Jalapa	Convolvulus Jalapa *Radix*
Ipecacuanha	Callicocca Ipecacuanha Brotero, *Act. Soc. Lin.* *Radix*
Juniperi Bacca ——— Cacumen	Juniperis communis
Kino	*Arboris adhuc incognitæ Africanæ Gummi-resina*
Lapis calcarous	Carbonas Calcis
Lavandula	Lavandula Spica *Flos.*
Lauri Bacca ——— Folium	Laurus nobilis
Lichen	Lichen Islandicus
Limon	Citrus Medica *Bacca*
Limonis Cortex	*Ejus cortex exterior*
Linum catharticum	Linum catharticum
——- usitatissimum	Linum usitatissimum *Semen*
Lithargyrus	Oxidum Plumbi semi-vitreum
Magnesia sulphurica	Sulphas Magnesiæ
Malva	Malva sylvestris
Manna	Fraxinus Ornus *Succus concretus*
Marrubium	Marrubium vulgare
Mastiche	Pistacia Lentiscus *Resina*
Mel.	Apis mellifica *Mel.*
Mentha piperita	Mentha piperitha Var. *a.* Smith, *in Act. Soc. Lin.*
——— viridis	Mentha viridis Var. *a.* Smith, *in Act. Soc. Lin*
Menyanthes	Menyanthes trifoliata
Mezereum	Daphne Mezereum *Radicis cortex*
Morus	Morus nigra *Bacca*
Moschus	Moschus moschiferus *Materia peculiaris*
Myristica	Myristica moschata *Nucleus*
Myrrha	*Arboris adhuc incognitæ Gummi-resina*

Nitrum	Nitras Potassæ
Olibanum	Juniperus Lycia *Gummi-resina*
Olivæ Oleum	Olea Europæa. *Drupæ Oleum expressum*
Opium	Papaver somniferum. *Capsulæ immaturæ succus concretus Orientalis.*
Opoponax	Pastinaca Opoponax *Gummi-resina*
Origanum	Origanum vulgare
Ovum	Phasianus Gallus *Ovum*
Papaver Rhœas	Papaver Rhœas *Corolla*
——— somniferum	Papaver somniferum *Capsula matura*
Petroleum	
Pimenta	Myrtus Pimenta *Bacca*
Piper longum	Piper longum *Fructus immaturus siccatus*
——— nigrum	Piper nigrum *Bacca immatura*
Pix Burgundica	Pinus Abies *Resina præparata*
—— liquida	Pinus sylvestris *Resina præparata*
Porrum	Allium Porrum *Radix*
Potassa impura	Carbonas Potassæ impura
Pterocarpus	Pterocarpus Santalinus *Lignum*
Pulegium	Mentha Pulegium
Pyrethrum	Anthemis Pyrethrum *Radix*
Quassia	Quassia excelsa *Lignum*
Quercus	Quercus pedunculata *Cortex*
Resina	Pinus sylvestris *Resina*
Rhamnus	Rhamnus catharticus *Bacca*
Rheum	Rheum palmatum *Radix*
Ricini Oleum	Ricinis communis *Seminis Oleum fixum*
Rosa canina	Rosa canina *Bacca*
—— centifolia	Rosa centifolia *Corolla*
—— Gallica	Rosa Gallica *Corolla*
Rosmarinus	Rosmarinus officinalis *Cacumen*
Rubia	Rubia Tinctorum *Radix*
Ruta	Ruta graveolens
Sabina	Juniperis Sabina *Folium*
Saccharum ——— purificatum	Saccharum officinale *Succus expressus præparatus*
Sagapenum	*Plantæ adhuc incognitæ Gummi-resina*
Salix	Salix Caprea *Cortex*
Sambucus	Sambucus nigra *Flos.*
Sarsaparilla	Smilax Sarsaparilla *Radix*
Sassafras Lignum ——— Radix	Laurus Sassafras
Scammonia	Convolvulus Scammonia *Gummi-resina*
Senega	Polygala Senega *Radix*
Senna	Cassia Senna *Folium*
Serpentaria	Aristolochia Serpentaria *Radix*
Sevum	Ovis Aries *Sevum*
Simarouba	Quassia Simarouba *Cortex*
Sinapis	Sinapis nigra *Semen*
Soda muriata	Murias Sodæ
Spartium	Spartium scoparium *Cacumen*
Spermaceti	Physeter macrocephalus *Materia peculiaris*
Spigelia	Spigelia Marilandica *Radix*
Spiritus rectificatus Hujus pondus specificum est ad pondus Aquæ distillatæ ut 835 ad 1000.	
Spiritus tenuior Hujus pondus specificum est ad pondus Aquæ distillatæ ut 930 ad 1000.	
Spongia	Spongia officinalis

Squilla	Ornithogalum Squilla. Sims, *Bot. Mag.* *Radix*
Stannum	Stanni Limatura
Staphisagria	Delphinium Staphisagria *Semen*
Styrax	Styrax officinale *Balsamum*
Succinum	
Sulphur	
——— sublimatum	
Tabacum Virginianum	Nicotiana Tabacum *Foliam Siccatum*
Tamarindus	Tamarindus Indica *Leguminis Pulpa*
Taraxacum	Leontodon Taraxacum *Radix*
Tartarum	Super-Tartris Potassæ impura
Tartarum purificatum	Super-Tartris Potassæ
Terebinthina Canadensis	Pinus Balsamea *Resina liquida*
———— Chia.	Pistacia Terebinthus *Resina Liquida*
———— vulgaris	Pinus sylvestris *Resina*
Testa	Ostrea edulis *Testa*
Thus	Pinus Abies *Resina concreta*
Tormentilla	Tormentilla officinalis Smith, *in Flor. Brit.* *Radix*
Toxicodendron	Rhus Toxicodendron *Folium*
Tragacantha	Astragalus Tragacantha *Gummi*
Tussilago	Tussilago Farfara
Valeriana	Valeriana officinalis Var. sylvestris *Radix*
Veratrum	Veratrum album *Radix*
Viola	Viola odorata *Flos recens*
Vesicatorius	Meloe Vesicatorius
Vinum	Vinum album Hispanicum *Sherry* dictum
Ulmus	Ulmus Campestris *Liber*
Uva passa	Vitis vinifera *Bacca præparata*
Uva Ursi	Arbutus Uva Ursi *Folium*
Zincum	
Zingiber	Zingiber officinale Roscoe, *in Act. Soc. Lin.* *Radix*

The preparations and compounds are exhibited under the following heads:

Acida	Tincturæ
Alkalina	Ætherea
Ferrea	Vina
Sales	Aceta
Sulphurea	Mellita
Metallica	Syrupi
Vegetabilia	Confectiones
Olea Expressa	Pulveres
Olea Distillata	Pilulæ
Aquæ Distillatæ	Partium Animalium præparatio
Decocta	Emplastra
Infusa	Cerata
Mucilagines	Unguenta
Extracta	Linimenta
Misturæ	Cataplasmata.
Spiritus	

Upon these divisions the limits to which we are confined prevent us from making more than a few observations.

Among the acids we perceive a form for the citric, now first introduced into the list, which will be found a useful and elegant medicine; we have a new form for the nitric, and the flores benzoës assume the name of acidum benzoicum.

In the alkalines we meet with no great difference, except in the change of names, which, for the most part, are shortened from those of the Edinburgh Pharmacopœia.

The same general observation may apply to the earths and salts, which, under the existing Pharmacopœia, form one common chapter with the two preceding divisions. The chapter sales employs the term soda instead of that of natron.

The sulphurea of the proposed Pharmacopœia is nearly a transcript of the preparata e sulphure of that now in use.

Among the metallica we perceive the pulvis antimonialis ordered to be prepared with half the quantity of sulphurated antimony to that of gross antimony, as under the present form. A useful and well-known preparation of arsenic is introduced under the name of liquor arsenicalis. Copper furnishes two prepara-

tions, cuprum ammoniatum and liquor cupri ammoniati; and iron several additional forms.

Among the distilled waters, the aqua anethi is banished, and the aqua carui introduced in its stead.

The addition to the chapter of decoctions is numerous, and consists chiefly in a form of this kind for the dulcamara, lichen, senega, and veratrum.

To the infusions there is also a very numerous addition: angustura, cloves, cascarilla, cinchona, columbo, quassia, rhubarb, simarouba, tobacco, digitalis, tar, horse-radish, each becomes a separate subject of this mode of preparation.

Among the mucilages, that of tragacanth is omitted.

The extracts afford us new preparations in the hop (humulus lupulus) poppy, sarsaparilla, dandelion (taraxacum), and hemlock.

The mixtures give us a new form for gum guaiacum.

The spirits revive the old spiritus anisi, and spiritus raphani, the latter under the newer name of spiritus armoraciæ compositus.

The chapter of tinctures provides a new form for capsicum, digitalis, humulus, hyoscyamus, kino.

The aceta give us a form for the colchicum.

The syrupi provide a form for the lemon, and order the syrupus papaveris somniferi to be prepared from its extract.

The term confectiones is intended to embrace equally, electuaries, confections, and conserves: from this chapter several of the existing forms are banished.

The list of pulveres is also considerably diminished, chiefly by a rejection of several of the cretaceous preparations.

Among the pilulæ we now meet with a gamboge pill: the opium pill is banished.

The list of emplastra is diminished in a few forms, and enriched by a new Preparation, entitled emplastrum thuris cum opio.

The cerata are increased by a ceratum sabinæ, and C. vesicatorii.

The unguenta are much diminished; several of those, indeed, in the existing Pharmacopœia being transferred under a different preparation to the chapter of cerata: while as new articles we have an U. hydrargyri nitrici, U. hydrargyri nitrico-oxydati, and U. veratis.

The liniments give us as a new preparation, a lin. æruginis.

The cataplasms offer us a new form for one prepared from meal and yeast, under the title of C. effervescens.

PHARMACOLITE, in mineralogy, is of a snow-white colour, and it occurs in small crystals, though sometimes in other forms. Internally it is glistening, with a silky lustre. Its fracture is radiated or fibrous: it also presents large and small granular, distinct concretions. The crystallized varieties are translucent; it is very tender, and easily frangible; it is soluble in nitric acid, without effervescence; it consists of

Arsenic acid	46.5
Lime	23.
Oxide of cobalt	0.5
Silex and alumina	6.
Water	22.5
	98.5
Loss	1.5
	100.0

This mineral is found in veins of granite in Germany and France.

PHARNACEUM, in botany, a genus of the Pentandria Trigynia class and order. Natural order of Caryophyllei. Essential character: calyx five-leaved; corolla none; capsule three-celled, many-seeded. There are fourteen species, chiefly natives of the Cape of Good Hope.

PHARUS, in botany, a genus of the Monoecia Hexandria class and order. Natural order of Gramina, Gramineæ, or Grasses. Essential character: calyx glume two-valved, one-flowered: male, corolla glume two-valved: female, corolla glume one-valved, long, involving; seed one. There are three species, natives of the East Indies.

PHASCUM, in botany, a genus of the Cryptogamia Musci class and order. Generic character: capsule ovate, veiled, sub-sessile, or on a short bristle, closed on every side, sometimes with the rudiment of a lid, never opening: males, subdiscoid, terminating, or gemmaceous axillary.

PHASEOLUS, in botany, *kidney bean*, a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ, or Leguminosæ. Essential character: keel with the stamens and styles spirally twisted. There are twenty-one species.

The varieties of the kidney bean are very numerous: the P. coccineus, scarlet kidney bean, is by some considered as a distinct species; its twining stalks, if properly supported, will rise to the height of twelve or fourteen feet; the leaves are smaller than those of the common garden bean; the flowers grow in large spikes, of a deep scarlet colour; the pods are large and rough; they are more esteemed for the table, by many people, than the others.

PHASES, in astronomy, the several appearances or quantities of illumination of the Moon, Venus, Mercury, and the other planets; or the several manners wherein they appear illuminated by the Sun. With regard to the Moon, these phases are very observable with the naked eye; by which she sometimes increases, and sometimes wanes; is now bent into horns, and again appears as half a circle. By means of a good telescope, the like phases may be observed in Venus and Mars. Copernicus, before it was possible to ascertain the fact, by means of glasses, foretold that it would, at some period or other, be ascertained, that Venus underwent all the changes to which the moon was subject. Galileo was the first person, who, by actual observation, confirmed the truth of Copernicus's theory.

PHASIANUS, the *pheasant*, in natural history, a genus of birds of the order Gallinæ. Generic character: bill short, strong, and convex; head covered in some degree with caruncalated flesh; legs generally with spurs. There are ten species.

P. gallus, or the wild pheasant, inhabits the forests of India, and has been seen, indeed, by navigators in almost all the Indian and South Sea islands. This is the unquestionable origin of all the domestic varieties throughout Europe, of which we shall notice the following.

P. gallus, or the dunghill cock. The most interesting animal under this variety is the game cock, which is found in great perfection of vigour and courage in England, and the irascibility and jealousy of which has, in almost all ages, occasioned it to be employed in the sanguinary diversion of cock-fighting. This practice is carried to a great extent, even among the mild inhabitants of China and India, whose manners, or principles, might be conceived in the highest state of repugnance to it. The polished civilization of the Athenians did not prevent their engaging in it with considerable ardour, and the Romans encouraged it with all that fondness which might be expected from a nation established by rapine, and as it were educated in blood. From them it was introduced into England, where it has occasionally been patronized by monarchs, and is still indulged in both by lords and plebians with considerable frequency, though, probably, not to such a degree as in some former periods. The appearance of this animal, when under the agitation of strong feeling, is highly interesting, indicating boldness, freedom, and energy, of a very superior character; and the beauty of his plumage, and gracefulness of his movements, combine strongly to heighten the effect. The female is remarkable for great fecundity, and for the most exquisite parental fondness and sensibilities; the poets of almost every age and nation having introduced it as the most expressive image of maternal duty and tenderness. It is finely observed, by the great French naturalist, that "dull and tasteless as the business of incubation may be thought by us, nature may have made it a state of extraordinary joy, connecting, probably, sensations of delight with whatever relates to the continuance of her offspring." In some countries, and particularly in Egypt, chickens are produced from eggs without the assistance of the parent bird. The eggs are enclosed in ovens heated with extreme care and precision, and turned at certain intervals, and thus hundreds, and even thousands, are annually produced in one establishment; but chickens, thus produced, are stated to be rarely so vigorous as those hatched in the natural mode. See Aves, Plate XII. fig. 1

P. colchicus, the pheasant. These birds are found in almost every territory of the old continent; but are not to be met with in America. Their wings, from their shortness, are ill calculated to sustain a long flight. They resemble the partridge in breeding on the ground, and lay from twelve to fifteen eggs. In many parts of this kingdom they have been introduced with great success, exhibiting an interesting and beautiful object to the admirer of nature, and furnishing variety to the pursuits of the sportsman, as well as to the luxuries of the table. Pheasants prefer low woods bordering upon valleys, are extremely shy, and never associate but in the spring. The hen pheasant has been occasionally discovered with the feathers almost universally peculiar to the male; and, indeed, this circumstance takes place in several other genera of

birds. The crowing of the pheasant is very similar to that of the former species, but not so loud or so distinct. There are many varieties of the pheasant tribe kept in the aviaries of the curious in England, exhibiting the most admirable plumage, but not sufficiently hardy to endure the rigours of winter in that climate, where the P. colchicus alone has become nationalized. See Aves, Plate XII. fig. 2.

PHEASANT. See PHASIANUS.

PHELLANDRIUM, in botany, *water hemlock*, a genus of the Pentandria Digynia class and order. Natural order of Umbellatæ, or Umbelliferæ. Essential character: florets of the disk smaller; fruit ovate, even, crowned with the perianth and pistil. There are two species, *viz.* P. aquaticum, common water hemlock, and P. mutellina: the former is a native of most parts of Europe: Linnæus informs us, that the horses in Sweden, by eating this plant, are seized with a kind of palsy; this effect is not to be ascribed to the plant, but to a coleopterous insect breeding in the stalks: in the winter the roots and stem, dissected by the influence of the weather, afford a curious skeleton or net-work.

PHILADELPHUS, in botany, *syringa*, a genus of the Icosandria Monogynia class and order. Natural order of Hesperideæ. Myrti, Jussieu. Essential character: calyx four or five-parted, superior; petals four or five; capsule four or five-celled, many-seeded. There are four species, of which P. coronarius, common or white syringa, is a shrub that sends up a great number of slender stalks from the root, seven or eight feet in height, putting forth several short branches from their side; leaves ovate, lanceolate, three inches long, and two broad in the middle, terminating in acute points, with several indentures on their edges; they have both the taste and scent of fresh cucumbers; the primary flower is five-cleft in the calyx, corolla, pistil, and capsule; the rest are four-cleft. It is a native of the South of Europe.

PHILLYREA, in botany, a genus of the Diandria Monogynia class and order. Natural order of Sepiariæ. Jasmineæ, Jussieu. Essential character: calyx four-toothed; corolla four-cleft; berry two-celled; seeds solitary. There are three species, which are distinguished by the form and indentations of their leaves; they are shrubs, and natives of the southern countries of Europe; they are evergreens, and sufficiently hardy to thrive in the open air, being rarely injured, except in very severe winters, which causes their leaves to fall, and kills some of the weaker branches; these are repaired by new shoots the following summer; there are few evergreens which are hardier than the phillyrea, or that deserve more to be cultivated for pleasure.

PHILOLOGY, a science, or rather assemblage of several sciences, consisting of grammar, rhetoric, poetry, antiquities, history, and criticism. Philology is a kind of universal literature, conversant about all the sciences, their rise, progress, authors, &c. It makes what the French call the *belles lettres*. In the universities it is called humanities. Anciently, philology was only a part of grammar.

PHILOSOPHER a person versed in philosophy; or one who makes profession of, or applies himself to, the study of nature and morality. See PHILOSOPHY.

PHILOSOPHER'S *stone*, the greatest object of alchymy, is a long sought for preparation, which, when found, is to convert all the true mercurial part of metal into pure gold, better than any that is dug out of the mines, or perfected by the refiner's art.

PHILOSOPHY, *mental.* 1. That science which teaches us the laws of our mental frame, which shews us the origin of our various modes and habits of thought and feeling, how they operate upon one another, and how they are cultivated or repressed, is mental philosophy, or the philosophy of the human mind. The well directed study of it calls into action and improves the highest intellectual faculties; and while it employs the powers of the mind, it suggests the best means for their culture, and the best mode of their direction. It enables us to trace the intricacies of our own hearts, and points out the proper discipline for their correction. It discovers to us the real excellencies of the mind, and guides us in our efforts for the attainment of them. To success in forming the moral and mental character of others, it is more or less essential; for it discloses the nature of our influence over their minds, and the best mode of exercising it so as to bring their various faculties into the best adjusted and most perfect state. Pursued with proper views, and in a proper manner, it lays the best foundation for the highest degrees of intellectual, moral, and religious improvement.—" There are difficulties," to use the words of the great Hartley, " both in the word of God and in his works; and these difficulties are sometimes so magnified as to lead to scepticism, infidelity,

or atheism. Now the contemplation of our own frame and constitution appears to me to have a peculiar tendency to lessen these difficulties attending natural and revealed religion, and to improve their evidences, as well as to concur with them in their determination of man's duty and expectations."

2. The best ground-work for the pursuit of mental science, is an accurate judgment, a discriminating penetrating intellect, and a habit of correct and cautious reasoning; and therefore the best preparatory culture of mind is the study of the various branches of the mathematics and of natural philosophy. But habits of reflection and good sense are all which are essential to the beneficial pursuit of mental science; and with these, it will in all cases lead to results highly important to individual welfare and usefulness.—The young, in particular, will be led, by an acquaintance with the practical laws of the mind, to perceive how their present conduct affects their future character and happiness; to perceive the importance of avoiding a frivolous employment of their time, without any end beyond mere amusement; to perceive the impossibility of indulging in vicious gratifications, without lessening their means of happiness, and checking their progress towards excellence. They will learn how habits are formed almost imperceptibly, and when long exercised, how exceedingly difficult it is to eradicate them; they will learn to consider the formation of habits as requiring, therefore, their utmost circumspection. They will be enabled to discern what habits of thought and feeling are baneful, what useful; what means of happiness should be regarded as of primary value, what should be regarded as secondary only.—In short, there can be no hesitation in affirming, that next to the immediate pursuits of religion, to which the laws of the mind direct, a judicious acquaintance with those laws is the most important means for the right employment of that period of life on which the happiness of our existence, in a great measure, depends.

3. We cannot even attempt to give our readers a complete system of this important science; however brief it might be made, if it were as comprehensive as the subject requires, it would occupy too great a portion of this work: what we wish to aim at is, to give such a view of the leading laws of our mental frame, as may direct the thoughts of the inquirer into a right channel, and serve as a foundation for the results of attentive reflection, which reading may assist in gaining, but can seldom impart.

OF THE PRIMARY FACULTIES OF THE MIND.

4. That, whatever it be, which thinks, and feels, and wills, is called mind: that part of the human being which thinks, and feels, and wills, is called the human mind.

5. We observe without us and within us numerous phenomena; the object of philosophy is to deduce from them certain general laws, agreeable to which they are produced, and then to employ those laws in the explanation of other phenomena. Mental philosophy pursues the same method which has been so successfully adopted in natural philosophy; and as in physics similar phenomena are referred to the operation of some one cause or power, so in mental science those phenomena, which have all one common feature, are referred to some faculty or property of the mind, by whose operation these phenomena are supposed to be produced. What those mental or physical powers are, philosophy does not profess to explain.

6. If we hold a luminous body before the eye, it produces some change in the state of that organ, and this produces in the mind a feeling; this feeling is called a sensation. This name is also given to all those other feelings which are produced in a similar way, *viz.* owing to a change in the organs of sense, whatever be the cause by which the change is produced. The general fact or law is, that sensations are produced by what affects the organs of sense. Now to account for this fact, we infer that the mind is possessed of a power or capacity which we call sensation, or, better to avoid ambiguity, the sensitive power. This then is that power or capacity of the mind by whose operation it receives sensations from things which affect the organs of sense.

7. We know as a matter of fact, that though sensations cease soon after the exciting object is withdrawn, yet if they have been produced sufficiently often and vividly, the causes of feelings similar in kind remain in the mind, and those similar feelings can recur when no change is produced in the organs of sense. These are called ideas: they are the relicts of sensations.—Such is the general law or fact. The operation or act of retaining relicts of sensations, may, with the strictest pro-

priety, be termed retention; and to account for it, we infer that the mind possesses a power or capacity, which we may call the retentive power. This then is that power or capacity of the mind, by which it retains relicts of sensations.

8. Again; it is an indisputable fact, that these ideas or relicts of sensations, do not remain single in the mind, but become connected with one another, so that the recurrence of one, or of its corresponding sensation, will bring on another; and that in certain cases, they become so blended together, that the parts can scarcely be distinguished. Thus the word orange, either pronounced or thought of, will bring the idea of the appearance of an orange. Again, the idea of the word house is accompanied by a certain feeling, which is altogether different from that which accompanies the idea of the word ship: if we think about it a little, we usually have the idea of a particular house recalled; this is a simple idea (or idea of sensation or conception) connected with other ideas, but not combined with them: but, in general, if the word occurs without the mind dwelling upon it, we may perceive an indistinct feeling, which is composed of a variety of simple ideas, received from a variety of those objects to which we give the name house. That the feeling is thus composed we have a full right to assert, on an attentive consideration of the customary processes of the mind.—Simple ideas may then be connected with other ideas; or they may blend and coalesce with other ideas, so as to form new ones, which are called compound or complex ideas. The general fact is, that connexions and compositions take place among our ideas; and when thus connected or compounded, we say that they are associated together, and the connected or compounded group we call an association. To account for the formation of associations, we infer that the mind possesses a power or capacity of connecting or combining ideas, which may be called the associative power. This then is that power or capacity of the mind by which it connects and compounds ideas.

9. Once more; it is obvious that without any external excitement of the nerves by which muscular motion is produced, the mind can produce such motion; in other words, that state of the motory nerves by which muscular motion is effected, can be produced by the mind. We do not here inquire how the mind learns to use its influence over the motory nerves, but state the fact, that muscular motion can be produced by the mind without external excitement. To account for this, we infer that the mind possesses a power or capacity of influencing the motory nerves so as to produce muscular motion, which may be called the motive power.—We have no name appropriate to those states of mind which produce the changes in the motory nerves requisite for muscular motion; and we are, therefore, so far free from a difficulty which has accompanied us when speaking of sensations and ideas: these terms, as they are generally used, imply that the consciousness of the mind is excited. But it appears an almost indisputable fact, that the mental organs, whatever they be, by whose action the consciousness is excited, often are in a state of activity without such excitement of the consciousness; in other words, that those changes which, when accompanied with consciousness, are termed sensations and ideas, may take place, and produce their appropriate effect in the mental system, without exciting the conscious or percipient principle. In order to enter into the consideration of this important fact, it will be necessary to consider somewhat more explicitly, in what manner we employ the term mind, and to introduce some less customary terms, in order to avoid ambiguity.

10. In the philosophical sense of the term mind, it seems to belong exclusively to the conscious or percipient principle, whatever that be; but in common language we certainly employ it differently: *e. g.* no one hesitates in saying, "such a man has an extensive store of knowledge in his mind;" but no one supposes that at any one time a man perceives, that is, is conscious of, all the parts of that knowledge: in the same manner no one would hesitate in saying, "such a person has a great fund of valuable reflections for the conduct of life stored up in his mind, which he can produce whenever circumstances call for them;" but no one supposes that those reflections are always in the view of his mind, that is, that he is always conscious of them, that he always perceives them. All that can be meant in such cases, is, that the causes of his ideas (that is of his thoughts and feelings) remain in the mind, ready for excitement when they produce ideas.—Hence then the mind, in the common acceptation of the term in which we use it, consists of two parts, the conscious or percipient principle, and the organized substance, which furnishes to the former the objects of its consciousness or percipiency. What the

conscious or percipient principle is, is probably known to him only who formed it: we may believe consciousness or percipiency to be a property which is the necessary result of, or added to, a certain organized system of matter; or we may believe it to be a property of some substance essentially different from matter; and we apprehend it is not of much consequence which opinion is adopted: but it seems indisputable, that in the present state of knowledge, we cannot obtain, on either side, more than a bare preponderance of probabilities.

11. That organized substance, which, without any further medium, furnishes to the conscious or percipient principle the objects of consciousness or percipiency, may be called the sensorium. The parts of which the sensorium is composed, by whose motions or other changes, without any further medium, consciousness is excited, may be called the mental organs. By the mind, we understand the whole together, the conscious or percipient principle together with the sensorium; leaving it undecided, whether consciousness is a property of organized matter, or belongs to a substance essentially different from matter; and also, whether the sensorium be or be not the medullary substance of the brain. (See SENSATION.) Hartley, as is well known, adopts the affirmative in the latter case; and he supposes that the changes of the sensorium which affect the consciousness are vibrations of the medullary substance (see VIBRATION); we consider this hypothesis as a clog upon, at least, the adoption of his grand system of association, and should prefer the more general term, motions, if we professed to decide respecting the nature of the sensorium; as we do not, we shall employ the still more general term changes, since the term affections is already appropriated.—The changes in the sensorium, or mental organs, which may excite the consciousness, may be called sensorial changes. Of these some are produced by the impression of external objects upon the organs of sense; these may be called sensible changes; others, as we know by their effects, are producible without the presence of external objects; these may be called ideal changes, and are the relicts of sensible changes; a third class are those which are followed by muscular action, and may be termed motory changes. Each of these classes of sensorial changes may take place without consciousness, as we shall endeavour to show in the next paragraph. When sensible changes are accompanied with consciousness, they are called sensations; when ideal changes are accompanied with consciousness, they are called ideas; and as sensible and ideal changes are principally important to us when accompanied with consciousness, and it seldom is necessary to distinguish between those which do and those which do not excite it, we shall not usually depart from the customary nomenclature. We have no term appropriated to denote motory changes accompanied with consciousness: this deficiency probably arises from the circumstance, that muscular action is so much an object of the senses, that by association it is referred to the moving muscle, and not to the intermediate fibrous motions and sensorial changes; thus, while writing, all the motion seems to be in the fingers, and in the fingers alone, though even the minutest motion, except that which is produced by some external stimulus upon the motory nerve, implies motory changes of the sensorium, and should, scientifically speaking, be referred to the sensorium, or mind.

12. To show that sensible changes are not necessarily accompanied with consciousness, we observe, that the diminution of consciousness can be traced in its various stages, from the state of active attention, to cases where we have no reason to believe that consciousness is excited, where yet we have abundant reason to believe that there were sensible changes; because those effects are produced, which we know are produced by sensations (that is, by sensible changes of which we are conscious), and, as far as we know, in no other way. We cannot, consistently with our requisite limits, advance so many facts as may appear to some to be necessary to prove our statements, but the following will at least illustrate them.—Persons, much accustomed to employ notes in singing, sometimes feel so deeply interested in the thoughts and feelings excited by the words they are singing, that, though the notes continue to regulate their tones of voice, the sensible changes are altogether unnoticed by them; they do not excite the consciousness. Again, many who have been long accustomed to perform upon a musical instrument, and can play with ease at first sight, while playing a piece of music which they have not seen before, can converse and carry on a train of reasoning, and yet play correctly: the appropriate sensible changes must in

such cases be produced; for otherwise the proper motions of the fingers could not; but they are not accompanied with consciousness; as soon as they are, attention to the conversation, or train of reasoning, is interrupted. In the same manner, persons accustomed to read aloud, can continue to read aloud, even what they never read before, with at least correctness, and at the same time have their thoughts closely employed on other objects. The following case, stated by Dr. Percival, will by most be admitted as a strong corroboration of our principles. "Several years ago the Countess of——fell into an apoplexy about seven o'clock in the morning: among other stimulating applications, I directed a feather, dipped in hartshorn, to be frequently introduced into her nostrils. Her ladyship, when in health, was much addicted to the taking of snuff, and the present irritation of the olfactory nerves produced a junction of the fore-finger and thumb of the right-hand; the elevation of them to the nose, and the action of snuffing in the nostrils. When the snuffing ceased, the hand and arm dropped down in a torpid state. A fresh application of the stimulus renewed these successive efforts; and I was witness to their repetition till the hartshorn lost its power of irritation, probably by destroying the sensibility of the olfactory nerves. The Countess recovered from the fit about six o'clock in the evening; but though it was neither long nor severe, her memory never afterwards furnished the least trace of consciousness during its continuance." Now here the impressions produced by the hartshorn on the external organ, produced (by means of the nerves) sensible changes; and these, either through the medium of ideal changes, or, more probably, directly, produced motory changes, which (by means of the nerves) produced muscular action; and the whole without exciting consciousness. The gradual diminution of attention to, or the consciousness of, external objects of sensation, (the beat of a clock for instance), when the mind is becoming closely engaged upon some object of reflection, must be obvious to every one who thinks on what passes within him; and it cannot be requisite to enlarge on that point.—Those who admit what we have stated respecting sensible changes will feel little hesitation in admitting the same positions respecting ideal changes; because the latter are merely relicts of the former. Besides, there is another point of agreement. Sensible changes are produced without any effort of the mind, without any volition; so also are ideal changes. These latter, when not interrupted by sensations, follow one another in a train, without an effort, and often contrary to effort, regulated by the modes of connexion to which the individual is most prone. We believe that the position advanced respecting sensible changes, at the beginning of this paragraph, is equally applicable to ideal changes, *mutatis mutandis.* We shall give only one instance of that case in which consciousness entirely disappears, where yet we are certain, that there must have been ideal changes. Every one who can add up a column of figures, knows the nature of the operation, because it is learnt after the memory has acquired considerable power. The sum of two or three figures is first ascertained: the ideal change of that sum must of course be in the mind, and with that sum is combined the next figure, which forms a new sum, and so on. Now then there is the act of adding a number, the ideal change of which is in the mind, to another number of which there is a sensible change, and there is the ideal change of the sum, and so on, continually recurring: this we perceive when we are trying to add up slowly. But persons who are very familiar with such additions, will tell the result or final sum, apparently without an effort, apparently without the intervention of the mind, and certainly without any consciousness of the operations and ideal changes which must have passed in the mind before the result could have been obtained. It will not unfrequently be found, that persons very much habituated to these operations, can add up much more correctly while they leave themselves unconscious of the operations and ideal changes, than when they are conscious of them: and, what appears to us to settle the point, as far as consciousness is concerned, persons who, by constant custom, have become familiar with all possible combinations of small numbers, can go through a series of additions, and at the same time closely engage the attention upon another object; for instance, can dictate one or more letters.—As to motory changes, the fact is so obvious, that muscular actions, which must have their origin in the mind, as being regulated by impressions upon the external organs of sense, go on in long succession, and with frequent variation, while at the same time the attention is fully occupied by

some object of thought, that we should be ready to suppose nothing but opposition to a pre-formed hypothesis could lead a person to doubt, whether in such cases the muscular action excited the consciousness. Such an immense variety of muscular actions are continually taking place, in cases in which volition was once concerned, without in any way whatever attracting the notice of the mind, and this is so obvious a fact, and so satisfactorily accounted for by Hartley, that, however plausible the counter-considerations of the great northern philosopher, Dugald Stewart, (see Elements, chap. ii.) we cannot suppose that they can gain admission where the principle of association is thoroughly understood.

13. If this distinction between sensible and ideal changes, and sensations and ideas, be just; or rather, if the existence of sensorial changes, without consciousness, be admitted, (and we more and more feel satisfied that it is a fact, and if so, a very important one in our mental frame), then the four preceding faculties, or capacities of the mind, are to be referred to the sensorium, and are, in reality, the properties or powers of the mental organs. We feel disposed to admit, that the sensorium is the medullary substance of the brain; but we beg our readers to bear in mind, that what we have advanced is entirely independent of this opinion, and that indeed it is rather clogged by it. We use the terms sensorium and mental organs, because, in our opinion, they tend to give greater distinctness to our reflections on what passes within us; but it is with no view to decide whether they are material or immaterial.—Consciousness, or the percipient faculty, we consider as a distinct faculty from those already mentioned; it is the faculty or capacity by which the mind is affected by sensorial changes, whether sensible, ideal, or motory. Consciousness is in fact the notice of the mind itself; and the term is applied to that state, with which every sensorial change which excites the notice of the mind is attended.—When the consciousness is continued, either on a particular object, or on a particular succession of objects, whether or not that continuance is caused by volition, the state of the mind is called attention.—It is by consciousness alone that we have any knowledge of the other powers of the mind; and when directed to their operations, the appellation is peculiarly appropriate. When it is excited by sensible changes, it is usually called perception: consciousness referring to the operations of the mind, as such; perception to them, as produced by external objects. (For an account of perceptions, as distinct from sensations, see SENSATION.) We are conscious of ideas and sensations; we perceive the external objects which produce impressions on the external organs When the consciousness is suspended, as it often is, during sleep, &c. the ever active mechanism of the mental organs proceeds; in such cases, its operations sometimes excite the conciousness; otherwise we know of their existence only by their effects. On the other hand, consciousness necessarily implies sensorial changes; for to speak of the consciousness of nothing is an absurdity.

I. OF THE SENSITIVE POWER.

14. For a consideration of the leading facts respecting this faculty, we beg our readers to consult in this place the following articles, in their order; *viz.* SENSATION, SIGHT, SMELL, SOUND or HEARING, TASTE, and TOUCH. In the first will be found a brief account of the physical organ of sensation and motion.

II. OF THE RETENTIVE POWER.

15. Respecting this faculty, see the article RETENTION, where will also be found a few notices respecting ocular spectra.

III. OF THE ASSOCIATIVE POWER.

16. This principle, if not the sole cause of all our mental phenomena, except the original production of sensorial changes and tendencies to them, has some effect in the origin and modification of all of them. It is owing to this important principle, that sensations become the signs of thoughts and feelings, by which means man becomes a social being; that the whole mental furniture of perceptions, notions, affections, passions, sentiments, emotions, &c. is formed from the simple relicts of sensation; that man from mere sensation rises to intellect; that he becomes capable of reflection, of action. In short, whatever mental operation we attend to, except at the very earliest period of mental culture, we find association the cause of its production, or intimately concerned in it.

17. The fact of the connection which exists between many of our sensorial changes has been long known; but it has

generally been referred to the memory. Mr. Locke appears to have been the first who employed the principle of association to account for aberrations of judgment and feeling, and for customary connections of ideas; but he does not seem to have been at all aware, that all our ideas, except those which are produced by mere repetitions of uncompounded sensible changes (*i. e.* ideas of sensation, or simple ideas, § 8) are in reality formed by the influence of the same principle; that all our affections, and our mental pleasures and pains, are nothing more than the relicts of sensation variously combined by association.—It seems that Mr. Gay, a clergyman in the west of England, was the first who endeavoured to show the possibility of deducing all our passions and affections from association: his observations on this subject, however, as Dr. Priestley observes, amount to little more than conjecture. These, however, led Dr. Hartley to direct his thoughts to the subject; and by an union of talents in moral science, in natural philosophy, and in a professional knowledge of the human frame, with a mind unobscured by selfish tendencies, he was enabled to bring into one extensive system the progress of the mind, from its first rudiments of sensation, through the maze of complex ideas and affections, to show how man rises from sensation to intellect. "After giving the closest attention to the subject in a course of several years, it appeared to him very probable, not only that all our intellectual pleasures and pains, but that all the phenomena of memory, imagination, volition, reasoning, and every other mental affection and operation, are only different modes or cases of the association of ideas;" (more generally of sensorial changes;) "so that nothing is requisite to make any man whatever he is, but a sentient principle, with this single property, which however admits of great variety, and the influence of such circumstances as he has actually been exposed to." His great work was begun when he was about twenty-five years of age; it was published in the beginning of 1749, when he was little more than forty-three years of age. He lived nine years after, but he left it without any change; and he does not appear to have written any additional paper on the subject.—As Dr. H. expected, his work remained for a considerable time unnoticed. Tucker (A. Search) was obviously acquainted with it, and owed much to it; but he seldom speaks of Hartley, except respecting his hypothesis of vibrations. Dr. Priestley had the merit of bringing Hartley's system forward to the public notice; and the celebrity which he had acquired among different classes of the philosophic world attracted the attention of thinking people to the doctrine of association. About thirty years after the publication of the original work, he published an abridgment of it; in which he left out the deductions from the principal theory respecting the rule of life, the truth of Christianity, &c. and as much as he could of the hypothesis of vibrations. Since that time the system of Hartley has been rapidly gaining ground in South Britain; and it is now, probably, pretty generally adopted by those who think closely on the subject. In North Britain, owing partly to theological and metaphysical prepossessions, still more perhaps to Dr. Priestley's rough and unjustifiably severe attack upon three of the Scotch philosophers, whose mental and moral character ranked high among their contrymen, the principles of Hartley have made but little progress. The philosophical systems of Scotland have been somewhat modified by it; but those who rank the highest seem little inclined to admit it in its full extent. However, the writings of Dugald Stewart shew that he has done something towards clearing the way, and the Glasgow Professor of Moral Philosophy in his lectures does more; and there is reason to hope, that when the present generation has passed away, the true principles of mental science will gain a firm hold there as well as in South Britain. We ardently wish the extensive adoption of the Hartleyan system, because, while it satifactorily explains the causes of our mental phenomena, it furnishes the best guide in the moral and mental culture of the mind.

18. We have already stated that the associative power has two grand modes of operation, connection and composition: it is not easy to keep them distinct; but in many cases it is practicable, and often tends to precision in our reflections and reasonings. In what we shall advance respecting the operations of this power, we shall keep this distinction somewhat in view. We shall state, first, the classes of connections which exist among our sensorial changes; and, secondly, some of the principal laws of connections: we shall then proceed to detail some of the leading facts relative to compositions, and the formation of our compound notions and feelings.—It would be most strictly

philosophical to begin with compositions; because connections are formed not only among simple sensorial changes, but among those also which are compounded; in other words, not only among sensations, simple ideas, and single muscular actions, but also among those which have been blended together into complex states: and we shall sometimes have occasion, in what we state as to connections, to suppose such compositions actually formed. On the other hand, connections are much more obvious and more easily comprehended than compositions; and a statement of some facts respecting the former will lead to an easier acquaintance with the latter.

19. "That one thought is suggested to the mind by another," says the elegant and philosophic Stewart, "and that the sight of an external object often recals former occurrences and revives former feelings, are facts which are perfectly familiar, even to those who are least disposed to speculate concerning the principles of their nature. In passing along a road which we have formerly travelled in the company of a friend, the particulars of the conversation in which we were then engaged, are frequently suggested to us by the objects we meet with. In such a scene we recollect that such a particular subject was started; and in passing the different houses, and plantations, and rivers, the arguments we were discussing when we last saw them, recur spontaneously to the memory.—The connection which is formed in the mind between the words of a language and the ideas they denote; the connection which is formed between different words of a discourse which we have committed to memory, and the connection between the different notes of a piece of music in the mind of a musician, are all obvious instances of the same general law of our nature.—The influence of sensible objects in reviving former thoughts and former feelings, is more particularly remarkable. After time has in some degree reconciled us to the loss of a friend, how wonderfully are we affected the first time we enter the house where he lived. Every thing we see, the apartment where he studied, the chair upon which he sat, recal to us the happiness we enjoyed together, and we should feel it a sort of violation of that respect which we owe to his memory, to engage in any light or indifferent discourse when such objects are before us."—So, again, every one must have noticed the connections which exist between our thoughts or sensations and muscular actions. A performer looks at the notes of his book, and the appropriate motions of his hands and fingers follow with immediate succession. While we are writing, the thoughts we wish to communicate suggest the appropriate words, and these, with an almost instantaneous succession of motions, are written on the paper before us. We are, perhaps, more struck with this in writing short-hand than long; the characters appear as the representatives of the thoughts of our mind, almost without knowing how they are made.

20. All these facts are obviously nothing else than cases of those connections, which are formed by the operation of the associative power among our sensorial changes; in other words, among our sensible, ideal, and motory changes; in other words, again, but less generally, among our sensations, ideas, and motory changes.—We should prefer employing, in what follows, the terms sensible changes and ideal changes, rather than the terms sensations and ideas, because these imply consciousness, which we have before stated is not necessarily excited by the operations of the sensitive and associative powers: we shall, however, content ourselves with requesting the reader to bear in mind, that whatever may be said respecting connections among sensations and ideas, might be stated more generally respecting connections among sensible and ideal changes. Whatever the sensorium be, or whatever be those changes of it which excite the consciousness, it is among those changes, that is, among the sensorial changes, that connections and compositions take place.

CLASSES OF CONNECTIONS.

First: a sensation may be associated with other sensations, ideas, and motory changes.

21. A sensation, after having been associated a sufficient number of times with another sensation, will, when impressed alone, excite the simple idea (§ 8.), corresponding with that other sensation.—Thus the names, smells, tastes, &c. of external objects, suggest the idea of their visible appearance; and the sight of them suggests their names, &c. In the same manner, a word half pronounced excites the idea of the whole word; the mention of the letters a, b, suggests the idea of c, d, &c.; the sight of part of an object suggests the idea of the whole;

and the sight of one object recals the visual idea of other objects which have been uniformly or very frequently seen with it.—Innumerable other instances might be given with little trouble, but we shall mention only one other, which may assist some of our readers in accounting for certain cases of apparitions. L. was one day hastily passing by a room in which a very excellent friend had usually sat in a particular chair, and in a particular part of the room. His thoughts at the time were employed on some object which did not excite deep attention, and the sight of the chair excited in his mind a vivid visual idea of his friend as sitting in that chair. The friend had been dead some weeks, and L. involuntarily came back for another vision, but without effect.—Such visual ideas, and similar ideas derived from the other senses, particularly from the hearing, are by Dugald Stewart called conceptions; and where they are vivid and easily excited, they frequently lead those who are inattentive to their sensations to suppose that they actually saw and heard, at a particular time, what they did not then see or hear.

22. Sensations become connected with ideas, so that the repetition of the sensation will excite the connected idea.—Of this case of connections the following will serve as examples. Words associated with ideas, will readily excite them even when very complex: the words hero, philosopher, justice, benevolence, truth, and the like, whether written or pronounced, immediately call up with precision the corresponding idea. The hearing of a particular national tune, is said to overpower the Swiss soldier in a foreign land with melancholy and despair; and it is, therefore, forbidden in the armies in which they serve. The sound recals various heartfelt recollections; the idea of the peace, and the freedom of their country, of the home from which they are torn, and to which they may never return. What trains of interesting thought and feeling are usually called up in the mind by the sight of the scenes of early pleasure, where passed those years when novelty gave charms to every sensation, every employment of the faculty; when hope presented no prospects but what were decked in "fancy's fairy frostwork," and present joys precluded all regret for the past.

23. Sensations may become connected with muscular action, that is, with those sensorial changes which are followed by muscular action; so that the sensation will excite the muscular action, without the intervention of that state of mind which is called will.—A person automatically (that is without any volition), turns his head towards another who calls him by his name. When the hand of another is rapidly moved towards the eye, we shut the eye without thinking about it, or even being conscious of it. When copying from any book, if a person is very familiar with the employment, the appropriate motion of the fingers immediately follows the impression produced by the appearance of the word. In the same manner the visible impression derived from musical notes regulate the motions of the performer. "While I am walking through that grove before my window," says Darwin, "I do not run against the trees or the branches, though my thoughts are completely engaged on some other object:" the sensible impression produced by the objects around, excite in the sensorium the appropriate connected motory changes, and these the action of certain muscles.

Secondly, ideas may be connected with sensations, ideas, or motory motions.

24. An idea associated a sufficient number of times with a sensation, will excite the simple idea belonging to that sensation.—Thus the ideas, whether simple or complex, which have been sufficiently associated with names, excite the ideas of their respective names. Hence it is that we find ourselves continually thinking in words; that is, the trains of ideas which pass in our minds, are accompanied with their corresponding expressions, when those expressions are familiar to us: and it may be remarked that the habit of thinking in words is one which contributes greatly to accuracy and facility of thought, and therefore one which the young reasoner will do well to cultivate.—Those who are habituated to reasoning, find their trains of reasoning so generally clothed in words, and words so necessary to their intellectual operations, that the words are what they most attend to, and some have even gone so far as to suppose that general reasoning is concerned merely about words and not about ideas. They seem to lie under a similar error with those who imagine that the visible appearance of objects is all we attend to when we speak of magnitude, shape, &c.; whereas the fact is, that the visible appearance is nothing more than a symbol which serves to introduce the connected complex idea into the mind and to keep its parts connected: and this

then is the grand end of words in general reasoning.—We are conscious while we are thinking, of employing the relicts of audible sensations; we seem to have faint sensations of sounds passing in the sensorium; but it appears probable that those who have long lost the use of their hearing, and have generally employed sight as the inlet of knowledge, have a train of visual, instead of audible conceptions. All, however, which we particularly wish to have noticed here is, that these things afford instances of the connections of ideas with sensations, so that the idea introduces the simple idea belonging to that sensation.

25. Next, an idea associated with an idea, (whether notion or feeling) will excite that idea. Thus the idea of benevolence will excite that of merit; of courage, that of honour; of great talents, that of respect; of cruelty, that of horror; of meanness, that of contempt.

26. Again, an idea associated with a motory change, will excite that motory change, (and its consequent muscular action.)—Thus the desire to perform a particular action will produce the corresponding voluntary motion of the limbs; joy produces a pleasing cast of countenance; fear excites trembling; and horror distortion. In the same manner when we are employed in committing our thoughts to writing, the idea of the words which we intend to commit to paper, if the character be not peculiar, or novel, will immediately suggest and be followed by the appropriate motion of the fingers, and this without the intervention of volition, sometimes without even the consciousness of the motory changes, or of the muscular actions produced by them. So also in speaking, unless some difficult pronunciation occur, the muscular actions requisite for the formation of the sounds follow immediately the conception of the words, without the intervention of the will.

Thirdly, motory changes, (and their correspondent muscular actions), may be connected with sensations, ideas, and other motory changes, (and their correspondent muscular actions.)

27. Muscular actions may be associated with sensations; that is, when muscular actions have been sufficiently long associated with sensations, the repetition of the muscular action alone will excite the simple idea belonging to that sensation. Thus the action of dancing will bring to mind the conception of the music with which it has been often accompanied. Again, children often accustom themselves to particular motions of the limbs, while committing to memory, or while repeating what they have learnt; and those muscular actions in many instances become necessary to their correct and ready recollection, and even to their recollection at all. Addison, says Miss Edgeworth, represents with much humour the case of a poor man, who had the habit of twirling a bit of thread round his finger; the thread was accidentally broken, and the orator stood mute.

28. So again muscular actions may be associated with ideas; that is, when muscular actions have been sufficiently long associated with ideas, those muscular actions will excite those ideas: thus dancing will introduce cheerfulness into the mind. So particular muscular actions have, from habitual connection, a tendency to excite certain trains of thought, or states of mind: those who have been accustomed to one posture while studying, find it difficult to study so well in any other posture; and persons who, while engaged in deep meditation, have been accustomed to any little motions of body, find the continuance of those motions requisite for the continuance of their abstraction of mind. It is upon the same principle that certain postures of body have a tendency to produce those feelings which all should have when addressing the Supreme Being.—The cases, however, in which muscular action introduces ideas either simple or compound, are much less numerous than those in which sensations and ideas introduce muscular actions. In fact it is not the usual order of association; and besides, it is sometimes very difficult to say what effect is produced by the muscular action itself, and what by the sensations which generally accompany muscular action. In the next case the point is clearer.

29. Muscular actions become connected with other muscular actions (that is, the motory changes which produce the one with those which produce the other), so that the former may introduce the latter without the intervention of the will. —If different muscular actions are produced together, they are called synchronous; if one immediately follows the other, they are called successive, and the association is in like manner termed synchronous or successive.—The motions of the hands when a person is playing upon

the piano-forte, the motions of the hands and feet in weaving and in spinning, and various other muscular actions which will readily suggest themselves to the reader, may be stated as instances of synchronous associations of muscular actions. The motions of the organs of speech in reading or speaking, of the feet in walking, and of the fingers in writing or speaking, are instances of successive associations of muscular actions.

30. These nine cases of the association of sensorial changes are comprehended by Hartley in the following general theorem: "If any sensation, A, idea, B, or muscular motion, C, be associated for a sufficient number of times with another sensation, D, idea, E, or muscular action, F, it will at last excite, *d*, the simple idea belonging to the sensation, D, the very idea, E, or the very muscular action, F." —The sensation itself cannot of course be re-excited, because that depends upon the presence of the object of the sense; but sometimes, as in an instance stated in § 21, the simple idea belonging to a sensation is so vivid, that it equals, if not surpasses the original sensation; and it should be observed, that the sensorial change corresponding to the sensation is the same in kind as that corresponding to the simple idea left by that sensation; that is, any sensible change and its simple ideal change are the same in kind, differing only in vividness, and sometimes equal in that respect.—It may also be well to observe here, that when Hartley and his disciples speak of muscular actions clinging together, they obviously mean that the motory changes of the sensorium become connected together, and not as some seem to have supposed, and indeed as their words imply, that the motions of muscles are connected without any intervention of the mind (taking the term in the popular sense). It is true they suppose that volition has nothing to do in the association when complete, though originally perhaps concerned in the formation of the association; and also that it may go on without even exciting the consciousness; but we know of none who suppose that the mental organs (the mind in the popular sense) are less concerned in the connections among muscular actions, than in those among sensations and ideas. All the sensorial changes may and do become connected together, and the one may produce the other, and so on, without the consciousness being excited; but no external impression, which does not act by stimulating or impelling the moving muscle, can produce muscular action without the action of the mental organs; and, in like manner, no muscular action can produce another muscular action (except what may be termed mere physical motion, such as might be produced by any foreign body mechanically acting upon the muscular system), without the action of the mental organs. The whole of the connection is mental, and we think that if this idea be kept in view, and employed in the explanation of the Hartleyan phraseology respecting connections among muscular actions, that it will remove some of the difficulties which are felt respecting this part of the Hartleyan system, and show that the objections which have been urged against it arose from an incomplete idea of that system.

LAWS OF CONNECTIONS.

We now proceed to our second object (§ 18), *viz.* to point out and illustrate some of the leading laws of that class of associations which we term connections; premising that many of the observations which follow are, as the reader will readily perceive, equally applicable to that class which we term compositions.—These laws regard, 1. The strength of connections; 2. The disunion of connections; 3. The formation of connections by means of intermediate links (which we may call the law of transference); and 4. Habitual biases to particular kinds of connections.

1. *The Strength of Connections.*

31. The strength and durability of connections depend partly upon the degree of attention with which the connected sensorial changes have been attended, and partly upon the frequency with which they have recurred in connection; less generally, partly upon the vividness of the connected ideas; and partly upon the frequency with which the connected ideas, or muscular actions, have recurred in connection.—We may adduce, as an illustration of the former cause of strength and durability, that circumstances of a light and trivial nature, which have occurred while our minds were occupied with subjects of a strongly pleasing nature, form no connection with the concurring train of ideas, even if the attention were drawn off by them. For instance, suppose we were attending to an interesting discourse, if

our attention were for a moment called off by the coughing of a person near us, the train of thought suggested by the sermon would form no connection with the cause of the interruption, and it would pass in the mind without the idea of the interruption being introduced. But suppose a poor man to have fallen down in a fit of apoplexy, the circumstance would strongly interest our sympathy and excite our attention; many feelings would be brought into active exercise; and the ideas which were at that time in the view of the mind, would probably ever after present with them those of the scene which so strongly affected us.—Hence the importance that those who have the care of education, should seize the happy moments when circumstances have peculiarly interested the mind, to connect with them those related maxims of prudence, benevolence, and piety, which so introduced may have a lasting effect in regulating the disposition; but which, brought in a form less interesting, will have no permanent bond of union, and will soon be obliterated.—Hence, too, the importance of instilling into the mind those principles which are designed to have a constant operation in the thoughts, and feelings, and actions, of life, in such a form that they shall become connected with those thoughts and feelings which have already a firm hold on the mind, and thus be brought into view and excited into action much more frequently and uniformly.—The effect of frequent recurrence in producing strength and durability of association, may be best explained by the associations which take place between words and their corresponding ideas. These connections are not in general attended with any particular cause of association, except frequency of recurrence, and therefore they are the most unexceptionable instances. Now, other things being equal, we find that those words which are most frequently called up in the mind in connection with the ideas to which they belong, have a closer connection with those ideas; that is, the idea suggests the word, and the word suggests the idea, with greater certainty, and the association is more permanent. The following remarks of Dr. Percival will illustrate this general principle. "Slight paralytic affections of the organs of speech," says the doctor, "sometimes occur without any corresponding disorder of the other parts of the body. Hence the effort to speak succeeds the volition of the mind slowly and imperfectly, and words are uttered with faltering and hesitation. These are facts of common notoriety: but I have never seen it remarked, that in these local palsies the pronunciation of proper names is attended with peculiar difficulty; and that the recollection of them becomes very obscure, or is entirely obliterated, while the recollection of persons, places, and things, remains unchanged. This confirms the theory of associations, and at the same time admits of an easy solution by it. For as words are arbitrary marks, and owe their connection with what they impart to established usage, the strength of this connection will be exactly proportioned to the frequency of their recurrence, and this recurrence must be more frequent with specific terms."

33. Besides these two universally operating causes of the strength and durability of association, it is proper to observe, that they depend also upon the predisposition of the mind, the habitual bias of thought and feeling, and the prevailing cast of the associations already formed. This may in some part be resolved into the first cause, the degree of vividness of the connected ideas; but in part it must be considered as separate. Where there are associations of a contrary tendency, the production of the new association implies the destruction of the old one; and hence it is that persons who have passed the prime of life, feel it so exceedingly difficult to acquire new associations which are in opposition to those long formed. Hence it is that all those improper biases of thought and feeling, which oppose the best regulation of thought and feeling, should be carefully shunned; all those associations carefully prevented, which lead the mind away from God and duty, or which simply check the reception of those which accord with the dictates of religion. They do more than directly injure by their own existence; they injure, also, and this in no small degree, by preventing the formation of those associations which directly prompt to the course which duty points out.

34. An acquaintance with these principles leads us to the direct method of confirming associations which are essential to our well-being; suppose, for instance, the connection of a regard to the will of God, with our conduct, we should endeavour to connect as much as possible those pleasurable feelings which have a tendency to strengthen the links of union; we should cultivate the connection by frequently and continually bringing it into action, and we should carefully cultivate

those related states of mind which have a tendency to foster and strengthen the connection. To avoid weakening it, we should be careful not to associate any contrary trains of ideas (for instance, we should never attach feelings of ridicule with any thing connected with religion), and should carefully avoid those breaks in the association which will follow neglect in its cultivation. And it is a most satisfactory idea, that if vicious associations may be formed so strongly as to lie beyond the power of the individual to annihilate them, virtuous associations may also be formed so strong and permanent, as to bid defiance to time and to temptation. These shall survive the wreck of nature, and shall adorn the mental fabric, when this world, and all its sorrows and enjoyments, shall be no more.

2. *Disunion of Connections.*

35. As connections are necessarily formed, and frequently without any volition on the part of the individual, by the before mentioned circumstances, it is another very important law of the associative power, that these connections are not indestructible.—We observe then, that an association may be destroyed either by the formation of other contrary associations, or by the repetition of it being in some way or other prevented. Thus, for instance, if we wish to destroy the association by which we have attached ideas of merit to those spurious ideas of courage which lead a man to sacrifice the life of a fellow man, and perhaps the happiness of several, to the dictates of offended honour, our aim must be to associate all the dreadful consequences of his conduct with the conduct itself; to call to mind the injury to society, resulting from the violation of its laws and the deprivation of an useful member; the injury resulting to the connections of the individual from the cruel breach made in their peace, and among their means of happiness; the injury to the individual himself, by hastening him, unprepared, into the presence of his Maker, with this additional act to answer for: even the injury to the avenger, by cultivating the feelings of resentment, by loosening the restraints of passion, may be added to the already numerous evils resulting from this exercise of private revenge. These, frequently brought into view, would destroy the incorrect association which we had formed; would associate demerit instead of merit with the conduct of the duellist; and attach the idea of merit strongly to him who nobly resisted the opinion of the world of honour, and declined obedience to the laws which it imposes, where those laws were in contradiction to the laws of his conscience and of his God.—So, in numerous other instances, where an association unfortunately exists in the mind unfavourable to the formation or exercise of good dispositions, it may be weakened gradually indeed, but certainly weakened, and at last destroyed, by the steady culture of opposite associations. That conduct to which pious benevolence prompts may acquire so attractive an appearance, that ideas of difficulty, of pain, of ridicule, which may have been attached to it, and which may have impeded its exercise, will gradually give way to those which the divine approbation affords, of present peace and future happiness.—But there is not always time for this slow procedure. It may be necessary, for individual happiness, that the baneful association should be destroyed, without one repetition of it to confirm its power. To the general culture of opposite associations must then be added a steady careful prevention of the introduction of the connected ideas. Situations must be avoided, words disused, company shunned, which have a known tendency to introduce a train of thought leading to the first link of the chain which we wish for ever separated.

36. When we hold it out as a grand law of association, that connections may be disunited by forming opposing associations, and by preventing their repetition, we would by no means represent it as in general an easy, or as in all cases a practicable task.—When associations have been long formed, and often repeated, particularly where they accord with the general bias of the mind, they often bid defiance to the most strenuous exertions of the individual. If he could for a long time prevent their repetition, and successfully cultivate opposing associations, the most inveterate associations would by degrees loosen their power; but when associations have been strengthened for a long period of time, by being frequently brought into play, and connected with other active associations, and at the same time accord with the prevailing disposition of the mind, the prevention of their repetition, and the culture of opposing associations, is scarcely practicable.—These things may be viewed in various lights, some gratifying to the mind, some which must urge every thoughtful person to shun the formation and culture of those associations which he must some time or

other wish to break. While they teach us to be assiduously careful to prevent all such, they also shew us that those which we must wish to cherish may, as well as others of a contrary character, become invincible; and while they direct those who have the care of the young carefully to cultivate those tendencies to feeling and action, that is, those associations which may serve as a check upon improper associations, while they direct them carefully to prevent those which may acquire a despotic rule in the mind, to the destruction of peace and virtue, they also diminish the anxiety which we are sometimes prone to feel, when we find ourselves unable to mould them exactly to that standard of thought and feeling which we wish.

37. It may be well to enlarge a little here. Numerous are the associations, particularly of a speculative nature, which yield to the influence of time and change of circumstances. In many instances the destruction of the association depends upon the efforts of the individual; but in the greater number it is occasioned without his direct efforts, by the increase of his knowledge, by circumstances preventing the recurrence of the association, or by the formation of contrary associations upon more solid grounds. But that they may be broken should never be allowed as a reason for the formation of improper associations; for the difficulty is frequently great, in many instances insuperable, except by such discipline, such peculiar concurrences of circumstances as fall not to the lot of every individual. The association between certain motives and that state of mind which we call volition, formed in early life, and strengthened by frequent repetition, is frequently found so indissoluble, that it leads the unhappy individual to act against his better judgment, and the destruction of his corporeal, and even of his mental energies, produced by his conduct, prevents those exertions for his release which he wishes to make, but has not the power to attempt.—In every mind, more or less, circumstances generate desires and passions, these generate volition, and volition produces action. How few are there who have attained the power of voluntarily separating passion or volition, or rendering them less connected; or of repressing those passions which were previously invariably connected with the circumstances which gave them origin. In all men the train of thought is partly involuntary: how few are there who are capable of directing their associations into one channel by the exertion of volition, and employing them in one definite way; of destroying improper associations, and of forming new ones, actuated by a view to the claims of duty, and to their improvement in wisdom and virtue. How frequently do we see others (and self-knowledge will shew us repeated instances which come home to our own bosoms) in situations where they act against their better judgment, a situation which is so forcibly described by the apostle, "for that which I do, I allow not; for what I would, that I do not; but what I hate, that I do." This we can easily account for upon the principles of association. He who is in such a situation, may be convinced that certain actions are wrong, that they will infallibly injure his future happiness, that they must imbitter his present enjoyment: but his conviction comes too late. The object which promises the gratification of some or other of his powerful principles of action, presents itself to his mind; it strongly prompts his desires or his passions; the association between these and volition, is perhaps of very long standing, confirmed by repeated exercise, not counteracted, or but weakly, by any contrary associations, or by any exertion of the individual; it is impossible to overcome it, or at least, it can be overcome with extreme difficulty; the mind sinks under the trial, and the commission of the action tends to strengthen the association, to render the mind still more the slave of vice and misery.—The picture unhappily is not too highly drawn; and though the habit may not be so deeply fraught with unhappiness, few are those who can say that they have not one confirmed habit which they would wish to change, or at least to weaken. If these have made the attempt to destroy the connection between desire and volition, the difficulties cannot have appeared trifling.

3. *Law of Transference.*

38. We now proceed to state and to explain that important law of association, agreeably to which associations are formed by means of intermediate links. We must here request our readers to bear in mind, that we use the word idea in the wide sense in which it is employed by Hartley, to denote every internal feeling except sensation, whether simple or compound, whether or not accompanied

with pleasure or pain.—The law to which we have referred may be thus stated. One idea may become connected with a second, by means of their mutual connection with a third; and where it is not necessary to attend to this third or intermediate idea, the more the connection between the first and second is confirmed, the less will the third be perceptible; so that when the association becomes completely fixed, the intermediate idea is often lost entirely from the view of the mind. The absence of the intermediate idea is often so complete, that its ever having been present can only be discovered by tracing the progress of the connection between the extremes; and in certain cases where the association has been long in a perfect state, the difficulty may become so great, that we are inclined to admit an intermediate idea, only because we feel it in other similar cases, and perhaps in the very same connections in other individuals whose habits are less fixed.—This law, or mode of operation, of the principle which we call association, meets us at almost every step of our reflection on what passes within us. It may be termed the law of transference, and we shall state it again in another form. Let A, B, and C, represent three ideas, simple or compound, pleasurable, painful or indifferent. If A is connected with B, and B with C, A may be transferred to C, and be recalled by it, without B being present in the mind.

39. This is an exceedingly important and constantly operating law of association: it is thus that numerous, almost innumerable, phenomena are produced, which at first sight appear inexplicable upon any known principles, and which therefore are referred to instinct; that is, they are supposed to result necessarily from the conformation of the mind, without the operation of any acknowledged faculty of the mind. Such are the belief in what is called self-evident truths; the pleasures derived from objects which do not affect the mind by direct sensations, disinterested affections, &c.—Whenever we meet with the word instinct, applied to the human mind, we are to consider it simply as an appeal to ignorance; and though it seems often to be held out as the solution of a difficulty, it is, in fact, nothing more than saying, the feeling, or whatever else it be, springs up we know not how; we know nothing of its origin, progress, or exercise. The term instinct explains nothing, and though it is conveniently used with respect to the minds of brutes, of which we can learn nothing with certainty, yet when applied to the human mind, respecting whose operations we may often gain correct ideas, it is worse than saying nothing, for it stops investigation by a pretence of knowledge. It is true, we cannot trace many links in the chain of cause and effect; but as far as the great Creator has furnished us with powers, we need not be afraid to employ them, while their employment is conducted with judgment and caution.—We do not say that all those feelings which we are too apt to call instinctive, can in the present state of our knowledge be completely analyzed, and traced to their origin; but while so many can, so many too which in no respect differ from those which we cannot account for, except in the opportunity which we have of accounting for them, we have a full and fair right to say, that as attention to mental science increases, these difficulties will diminish, and that by degrees the whole of our mental furniture will be traced, as we can trace a great part of it, to sensations, retained by the retentive power, and combined and variously modified by the associative power.—We have no objection to the term natural feelings, &c. rightly explained; the word is abused, and often means the same as instinctive. We understand by the term those feelings, &c. which in all cases, where there is not something peculiar in the individual, will spring up in the mind, in consequence of the influence of generally occurring circumstances upon the powers with which the great Former of the mind hath endowed it. For instance, the parental, the filial feelings, &c. are natural feelings: in all cases where there is not something wrong in the individual, these feelings will spring up in his mind in consequence of the influence of generally occurring circumstances upon the powers with which the mind is endued. So also a great variety of other feelings, which, with the strictest propriety, may in this sense be termed natural.—Some objection, however, lies against another word often used in a similar way. Such feelings are said to be *implanted*. If the word be understood to mean nothing more than what some do mean when they use it, that the feelings, &c. spring up in the mind with the same certainty as though they had made a part of the original structure of the mind, all is well. But if it be understood to mean that these feelings do form a part of the original structure, then it im-

plies the same cutting of the Gordian knot, the same appeal to ignorance, which is implied in the use of the word instinctive. If, however, we can restrict its signification in our minds, we shall do well. Let it mean no more than that the feelings, &c. to which it is applied, are the necessary results from those powers which the Supreme Being has implanted in us; in fact, let it have the same general meaning as natural, with rather more force, denoting the necessity of their arising from the powers which are given us, and we shall not be giving way to those erroneous views which we must unlearn before we can acquire truth.

40. We need not go far for instances which will explain the law of transference. Suppose a person acquiring another language, the French, for instance; he learns the meaning of a French word by means of the corresponding English word; by degrees, as the French word becomes familiar to him, it is understood without the English word being thought of. Here the signification, that is, the idea connected with the word, may be called A, the English word B, and the French word C; by frequent connection between A and C, by means of B, A is transferred to C, the signification is transferred to the French word, so that B the English word is no longer wanting to form the link of union.—When a young person has acquired some facility in construing French, he generally reads his French work in English; but when he has acquired a pretty complete knowledge of the language, he reads it in French; that is, he understands it without the intervention of the corresponding English words.—Those who are conversant with short-hand, can read it without thinking of the long-hand; yet they learnt this through the medium of the long-hand words.—Those who have long learnt to read, and who have read much to themselves, seldom think of the sound of the words when they are reading to themselves. When we are pretty familiar with a subject, a single glance of the eye over a page of a clear printed book, will convey to us the idea of its contents, when perhaps not a single word has particularly attracted our attention, when certainly there has not been time for the mind to think of the sound of the words. We do not recommend this habit of reading to young persons; but simply state a fact which is very convenient and useful to the mind, which has gone through sufficient discipline of accuracy, &c. Now it is obvious that in almost all cases, persons learn to understand written words through the medium of spoken words.—One more instance and we have done with mere illustration. Those who are familiar with writing never think of the printed word, unless any particular circumstance call it to the mind. Yet there are very few instances in which the written word is not connected with the spoken word by means of the before learnt printed word.

41. I now proceed to show the application of this law, in explaining certain phenomena of belief, and the origin of disinterested affections. I am not now to attempt the explanation of the formation of the complex feeling which we call belief, nor of those complex states of mind which we call affections; but supposing them formed, to explain some facts respecting them, that is, to show how these facts accord with the general law of association which I have been stating.—Belief is transferable from the reasoning to the result of that reasoning. Suppose a proposition depends for its truth upon a great number of other propositions; if, as we go along, every step is believed to be true, and every connection of one step with another appears to be a just one, the feeling of belief is successively transferred from one step to another, till at last we come to the result, the proposition which we wish to prove, and the feeling will be connected with this, and will remain with it, when all the steps by which its truth was shewn are entirely lost from the view of the mind. Every one admits this; and every one who has gone through the process knows it to be so.—There are almost innumerable instances in which we find the feeling of belief connected with ideas, without our being able at once to say, or even to say at all, how we acquired the connection. In this instance some philosophers refer to certain instinctive principles, by which we are necessarily led to believe, without any further reason than that our mental constitution compels it. But we need not resort to such hypotheses; they do great injury, by checking the researches of the intellect, and in some cases, by leading people to suppose opinions well founded, which have no further ground than an almost accidental, or, at any rate, unjust transfer of belief, by means of what was itself, perhaps, intitled to no belief.—There are certain results of reflection and observation, which we call experience; and it is generally wise to

trust to them. But before a man yields to his experience, in opposition to the clear evidence of others, or to well-founded and well-connected reasonings, he should consider what experience is, and on what ground he has connected belief with it. He will find that belief is not a necessary attendant upon his experience, but that it has been connected with it by means of intermediate links, which might themselves have no satisfactory claim to belief. For instance, if a man has not observed accurately, or has not a correct judgment, his experience may not be worth any thing, nor intitled to any belief. Now, in many cases, it is almost impossible to recal the intermediate links, in order to prove to ourselves the correctness of our experience, and yet we must act upon it; this shows the importance of cultivating in early life those habits of cool judgment and accurate observation, which shall give us a full right to believe, and to act upon our belief, in the results of reflection and observation; but some truths, it may be thought, have a necessary connection with belief. We admit that there are truths which are so accordant with all the grounds of belief, that they instantaneously excite the belief of those who have had the opportunity of knowing those grounds, but no further. You immediately believe, that $2 \times 2 = 4$; and you would think that man destitute of common sense who denied it, or who did not immediately admit it. Yet we are well convinced, that the belief is formed in consequence of a number of external impressions; or, to state it more familiarly, by frequently counting, in the early part of childhood. We perhaps have not the power of discovering the exact steps by which we have ourselves proceeded to the belief of this truth; but we can observe them in some good measure in others; and we can trace them in ourselves, in similar circumstances. Often belief in such truths is formed through the medium of parental authority, or that of instructors, and it is probable, that in many instances children know no more why $12 \times 12 = 144$, than that they find it so in their multiplication tables; but where it has been formed by trials of the truth, those trials are forgotten, and the truth alone is remembered.—We should gladly enlarge more on these points, but what has been already said will probably answer the two purposes which we have in view; to show the operation of association in transferring belief; and in leading to the inference, that belief ought not to be regarded as a proof of truth; and yet, that the being unable to point out all the grounds of belief, is not any reason why that belief should be given up.

42. Two opposite opinions have long been entertained, and are still often advanced, respecting the disinterestedness of the human mind; some have maintained, that the mind, in all its feelings and promptings to actions, is actuated by selfish motives; that, in fact, there is no action or feeling which can be called disinterested. Others have with more success maintained, that the mind can be, and often is disinterested; that a person frequently performs an action tending to the good of others, in a greater or less degree, without the remotest reference to himself, with no other motive than a desire to do the good which is the effect of the action. The degrading system of the former is seldom adopted but by speculative men, who have been led by circumstances, happily not universal, to see merely the dark side of human nature, and to form a more gloomy picture of its selfishness than truth would allow; or by others who have expected too much from the beautiful speculations of theory, and having been disappointed by comparing them with their own feelings in many instances, or with the general conduct of men, have thence gone to the unfounded opinion, that all the actions of all men are selfish. If the opinion of those who maintain the disinterestedness of the human mind, had not been carried to an extreme, it would have been attended with but little inconvenience; but unhappily its virtuous advocates have thought disinterestedness an innate principle of the mind, and have considered it as the first step towards true worth of character, whereas it is in reality the last; and have, therefore, decked the commencement of virtue in colours which belong only to its completion: and hence two practical ill consequences have followed; some persons have neglected the culture of disinterestedness, both in their own minds and in those of others, from supposing it to be a necessary quality of the mind: and others have been driven to despair, on comparing the representations of theory with the faulty state of their own minds; supposing that they could never attain to what is considered as alone intitled to the appellation of virtue.—The more correct views, surely, are, that disinterestedness is the last

stage of an affection; that it may be hastended or retarded, by attention, or neglect of the culture of that affection; and that disinterestedness, as the general character of the mind, is the highest point of excellence, and what should be our object, but can only be acquired by a long course of religious culture.—When an affection has arrived at its most complete state, in which it has no further end than its own immediate object, (that is, when the object is desired for its own sake,) the affection may be called disinterested; but as this term would thus be applied, not only to the worthy, but the baneful affections, we should be compelled to speak of disinterested cruelty, disinterested avarice, &c. we shall therefore call those affections which are in their ultimate state, ultimate affections.—Premising this, we shall adduce some instances which will explain the progress of an affection, from the state in which the object of it is a mean, to that in which the object of it becomes the sole end; that is, in which it is an ultimate affection.

43. The most simple instance, and what is frequently adduced for this purpose, is the love of money. Money is first an object of pleasurable feeling, merely as a means of procuring other things which are regarded as objects of desire. For a moment we may sometimes think of it as having some intrinsic value, independently of its utility as a means; but we may satisfy ourselves that this is not the case, by observing how little it is an object of interest to children who have not heard much about it, or seen it employed, or employed it themselves. A child is perhaps pleased with a piece of money as a plaything, but nothing further, and children sometimes advance considerably far in life before they feel its value. E. (a boy of 7 years old) was presented by his father with half a crown, as a reward for a very successful and persevering effort; he was delighted with the approbation which was shewn him, and as far as the money was a mark of that approbation it pleased him; but obviously nothing further. In small families children generally learn the value of money early, and we therefore mention the circumstance as an illustration of what we have just said, that originally it is merely desired as a mean. As persons advance in life, money is continually found to be the mean of a great number and variety of the sources of present enjoyment; hence pleasurable feelings are continually connected with it, and it becomes more and more an object of desire. In this stage of the progress of the love of money, it is desired as the means of procuring certain pleasurable feelings, without reference to the objects by which those pleasurable feelings are directly produced. And even in this state of it we find an instance of the law of transference. The pleasurable feelings resulting from the objects procured, or to be procured, by money, are associated with the money itself, without reference to those objects. To revert to one of the modes in which the law was proposed; here the pleasurable feelings which purchasable objects produce; the idea of those objects; and the idea of money, are the three sets of ideas. Money procures the object, the pleasurable feeling; hence the pleasurable feeling becomes connected by means of the intermediate links with money; and hence money becomes an object of desire, without any reference to the means of gratification which it procures.—Here, to use the other statement, the pleasurable feelings may be termed A, the object which produces them B, and money which produces those objects C; and by frequent connection between A and C by means of B, A is transferred to C; the pleasurable feelings are transferred to the idea of money (and consequently to money itself) and are called up by it without any reference to B, the object by which those pleasurable feelings were excited. The law of transference may, in this instance, and many others, be carried one step further. In this state money is desired, on account of the pleasurable feelings with which it is connected; but by degrees the desire is transferred from the pleasurable feelings with which it is connected to money itself, and money is loved for itself, without any reference to those pleasurable feelings. This is so important a fact in our mental constitution, and what can be explained only by association, that we deem no apology necessary for endeavouring so much at length to point out its application. Here A is the desire which is excited by B, the pleasurable feeling connected with C, the idea of money: by means of B, A, the desire is transferred to C, the idea of the money; and thus the money comes to be desired for itself, without any reference to the pleasurable feelings which it is the means of procuring. In this state the desire of money is become an ultimate affection; it is no longer desired as a means, but as an end; it is desired on its own account.

44. Illustrations of a similar kind might

be offered with respect to the filial, fraternal, and even the parental affections; and it might be shewn that they are only gradually disinterested; but at the same time the natural tendency is to disinterestedness: and that it is only where disinterestedness is opposed by the culture of wrong affections, (affections which, when become ultimate, are ever selfish,) and by neglect of those which are in all their stages worthy, and which hasten the progress almost indefinitely, that the mind stops at partial disinterestedness, or sinks into confirmed selfishness.—In opposition to these views, however, it may be advanced by some, that children are usually more disinterested than persons who have had experience in life. We shall make some observations on this point, which will at the same time throw some light on the progress of the filial affections. Children often appear disinterested where they are not really so, because we do not take into account the quick changes of their feelings; sometimes setting a light value upon what a few hours, or even minutes, before they were delighted with, and at other times the reverse. Hence they are readily induced to give away what they have before been delighted with, and to make what we erroneously think sacrifices without an effort.—But again, we are apt to think them disinterested when they give up what they really like, only, or principally, because they thus have a greater share of the pleasures resulting from their obedience to their friends' praise, or other rewards. Now the approbation of their friends is to children a thing of such value, that praise affords them some of their greatest pleasures. And therefore, when, for the sake of that approbation, they give up play-things or niceties, or any other objects of pleasure, so far from being disinterested, they are eminently self-interested; but their self-interestedness is of a better kind, one which with due care will prove a most powerful engine in the moral and religious culture of the mind, by increasing the influence of the parent and instructor.—Again, children are in general influenced more by present objects than by future objects, however far superior in their value and durability. Few children early attain such command over themselves as voluntarily to give up a present source of pleasure for a future one; and where it is done, it is rather in compliance with the wishes and injunctions of their friends, than from any comprehensive conception of the future good. It is an excellent thing to obtain the sacrifice by means of any worthy feeling; all we wish to observe is, that children do not feel the value of future pleasures, and therefore easily yield to that which is most powerful at the time. Hence therefore they appear disinterested, because they cannot calculate the value of the good which they relinquish; and do in reality prefer the greatest present pleasure, or rather they are in reality actuated by the greatest present pleasure.—We do however cheerfully admit that children very often are disinterested; for instance, will obey their parents, will tell the truth, will endeavour to increase the comforts of others, without any reference direct or indirect to any personal gratification; and we admit too that these same children too frequently as they grow up become more selfish, and sometimes the constitutional readiness with which they have in some instances become disinterested, will be the cause of their becoming selfish, and that to a degree which those of less promise never experience. All this may be easily explained, but we must confine ourselves to the fact, that children in a very early period shew great marks of disinterestedness. Now this may easily occur, especially where there has been proper culture on the part of the parent. Where the approbation of the parent has been made the greatest good, by being uniformly given to that which will promote the real happiness of the child; and where, consequently, prompt and cheerful obedience has been early and steadily cultivated, a tendency to obedience will soon become so habitual as to leave scarcely a wish to deviate even in cases where obedience requires real sacrifices, and in general to prompt to propriety of conduct, without any reference even to the increase of parental affection, or to the occurring of parental approbation. Obedience is then disinterested: and the affection on which it is founded—the desire of doing whatever a parent directs, is become ultimate. Where this is confirmed by other worthy feelings, the highest effects may be reasonably expected in the moral character; and the foundation will have been laid for that regard to the will of God, which is the beginning and the end of wisdom.—But we need not for this resort to any opinion of innate disinterestedness. Let us observe how it arose from firm but temperate decision on the part of the parents, from an enlightened wish on their part

to promote the happiness of their child, by making its present pleasure subordinate to its happiness on the whole, from checking their own irregularities of disposition, so as to raise no suspicion in its mind that their own pleasure was their object, and by aiming to connect, by all the rational means in their power, pleasurable feelings with obedience, painful feelings with disobedience. We suppose there never was yet an instance, where all this was done, and done sufficiently early, where the effect did not follow. And the habit of disinterested obedience may be formed much easier in the earliest period of life than in those further advanced. There are then no opposing habits which must be checked before obedience can be secured: little pains are quickly forgotten though their effects remain; future pleasures are thought of but little, and the value of their sacrifice not falsely estimated; above all, the constant connection is formed between good and obedience, by various methods of obedience, and between unpleasant feeling and disobedience.—The desire of obeying parental directions is the feeling which we have been considering; but precisely the same observations may be made with respect to the wish to increase parental happiness, and remove parental pains: and where parental influence has acquired such power, we need not go a step further to ascertain the cause of a disinterested love of truth and other virtues. We do not think that a child who has been thoroughly disciplined, so as to have formed the confirmed habit of prompt affectionate obedience, and who has had this feeling transferred to his heavenly parent, by the wise instruction of his earthly parents, will even wander far and long from the road of duty; but in other cases, where the habit is less confirmed, or not rightly directed, it often falls before the influence of erroneous views as to the efficacy of the means of private happiness, before the constant influence of example, before the influence of disappointment, &c.: but these effects our limits will not allow us to explain; we merely wished to show how disinterestedness might spring up very early in the mind.—These things, so far from giving any countenance to the theory that the human mind is originally disinterested, confirm the theory that disinterestedness is the growth of custom; and point to various important practical conclusions, which parents will do well to lay to heart, to make the regulating principles of their conduct.

45. We will now proceed to the two last objects which we had in contemplation, the formation of disinterested benevolence, and a disinterested love of duty. Every human being receives his first pleasurable impressions in society. His appetites are gratified by the assistance of his kind; and probably there is no agreeable feeling which is not in some way or other associated with those who attend him in the period of infancy and childhood. Hence arises sociality, or the pleasure derived from the mere company of others: and, as the child increases in years, the associated pleasure increases almost continually. In the innocent and generally happy period of childhood, he receives all his enjoyments in the company of others; most of his sports and amusements require a playfellow; and if by any untoward circumstances he is prevented from joining his companions, he feels an uneasiness which it is scarcely in his own power to remove, but which vanishes as soon as he can rejoin them.—But his happiness derived from others, depends greatly upon the happiness of others. He is happiest when those around him are happy; partly from the contagion of feeling, and partly because his means of happiness considerably depend upon the convenience of others. If his companions are ill, his sources of pleasure are diminished; if his parents are unable to take their customary care of him, he misses it in various ways, he loses the caress of affection, or the little kindnesses of parental tenderness. Hence the comfort and happiness of others necessarily becomes the object of desire; and even in children, it not unfrequently happens, that this desire becomes sufficiently disinterested to forego small pleasures, or endure small pains, in order to increase the comfort of their parents, or to prevent what would diminish it.—Benevolence is that affection which leads us to promote the welfare of others to the best of our power; and general benevolence is founded upon particular benevolence; for instance, upon affection to parents. We have seen the rudiments of it spring up; and that in some instances, even in children, it becomes disinterested: but it has been in only one branch, and it will be well to pursue it further.—The endeavour to promote the comfort or welfare of others, is almost invariably followed in the early part of life with an increase of pleasurable feelings. Parents approve, and tell children that God approves, of those who do good

to others. Children and young people are continually feeling and observing the good effects of benevolence, as manifested in their own conduct, or in that of others; and hence, in well-disposed children, the pleasurable feelings connected with benevolent actions are very strong; they are very glad to see others made happy, and very glad to be enabled to make others happy; the pleasure derived from the approbation of others, from the approbation of their own minds; the increase of good-will in the person benefited; and the accordance with all the religious feelings which are possessed, and with various circumstances less general, add such a stock of pleasurable feelings to the doing good to others, that by degrees it is an object of desire, altogether independently of any consideration beyond itself. A person who has completely gone through this process, desires to benefit others without the slightest reference to his own personal benefit, either in this world or in the next: he employs the different opportunities which present themselves to him of doing good to others, without thinking of any thing more than the immediate object. If it call for great exertion on his part, great efforts of self-denial, he brings to his aid the desire of following the dictates of duty, of obeying the commands of God, and, where his benevolence, his love of duty, and his love of God, are thoroughly purified from self, to do good he will forego great and any pleasures, and endure great and any pains, without a thought beyond the attainment of the good which he produces, and the obedience to the claims of God and duty. Is he not now a noble being, worthy the discipline which his heavenly father hath bestowed upon him? And would not any one, to attain this height, go through any correction or trial? A less height is often observed. Benevolence may, with the strictest propriety, be termed disinterested, when, in a considerable number of its promptings, it has no end beside the good which it proposes, and this is obtained by numbers; and by those who have attained this height, that improvement may be made, by cultivating a general love of duty, and a regard to the will of God, which refutes beyond the possibility of rational controversy, the opinion that every feeling of the human mind is selfish.—We surely need not show how these things illustrate and explain the law of transference, by which means become the ends. We shall, however, just point out, that the desire of doing good itself may sometimes be lost from the view of the mind in attention to the means of doing it. Some of our readers are probably considerably interested in the welfare of institutions for the promotion of the welfare of the poor and afflicted; these institutions were planned by benevolence, and benevolence prompts their support. It is the desire of doing good which has led to the frequently returning exertions which are made to keep them in vigour; but we have no doubt but the welfare of one or other of those institutions will often be found to be an object of the mind, without reference to the good it does. The mind rejoices in its success, without thinking of the benefit which will result from it. As soon as the attention is directed to the benefits, the mind dwells upon them as the ultimate reason of its pleasure; but that was not in the view of the mind. Whether we have been successful or not in making our readers feel the force of the assertion by this illustration, we are confident of the fact, that the means of doing good often themselves become ends; and that the desire of their successful furtherance, which was originally felt for them, merely on account of the good they promised or did, is at last felt without reference to that good; though, on the other hand, it would by degrees, though perhaps not very soon, decay, if it were proved to the satisfaction of the mind, that the means of the hoped-for good were and must be totally inefficacious.—But there would be no end to illustrations of this law, if we were to trace it out in all its operations. We are continually loving things because—and afterwards loving them for themselves alone: it extends to the love of duty in general, without any reference to those peculiar branches of it with which we have been more immediately concerned. All the pleasurable feelings arising from particular branches of duty, and all the tendencies to particular branches of duty, by degrees become connected with the idea of duty in general, which is, in fact, formed of all the ideas of particular branches, &c. which we have considered as right and our duty; hence duty becomes an object of desire, because parts of it are loved on their own account, and this hastens the progress of a disinterested love of duty in general. But leaving this out of the

question, a great variety of considerations make it an object of choice; and if it be pursued as a mean to obtain the object in view, with sufficient steadiness, and or a sufficient length of time, by degrees it is pursued as an end, and duty is then loved for itself.

46. We shall think ourselves fortunate if we have succeeded in giving a distinct idea of the progress of the mind from self to disinterestedness. There are few things in mental investigations more interesting, or of greater practical value, than the tendency to love and to desire to promote things which have no immmediate connection with our own good, without any reference to our own good.—That the human mind is capable of gross selfishness, which defies all present discipline to correct, is a fact which cannot be denied, and which should excite our vigilance and concern. But it is no less a fact, that it is also capable of disinterestedness which shall run through the whole of the conduct, and prompt uniformly and steadily to the promotion of others' welfare. The earliest pleasures are personal: I wish not to call them selfish, because we seem to appropriate that term to those feelings which have an explicit reference to our own real or imaginary good, and which prompt to this even at the expense of others; in this sense the human mind cannot with the least propriety be said to be originally selfish; but its earliest pleasures are personal, and its earliest desires are consequently personal. Its interest in the pleasures of others, arises from their connection with the personal pleasures; and consequently the desire of promoting their pleasures, the love of others is originally interested; that is, it is in consequence of its personal pleasures depending on the pleasures of others. There is nothing criminal in this, it is according to the laws of our mental frame; it is only criminal when the mind rests here; for it cannot, without being wrongfully imped-ed. The good of others promotes our personal pleasures, and hence it is originally that we desire to promote their good. By degrees the desire is transferred completely from the original end, personal pleasures, to the good of others, the original means, and then this becomes an end, and the desire is disinterested.

47. We feel the glow of pleasure in thus tracing the progress of the mind, and shewing that its tendency is to disinterestedness, and that it is often obtained in a comparatively universal extent. Let us not then listen to the degrading ideas of those who would persuade us that the most perfect benevolence is only the most refined selfishness; that all which is said by philosophers and moralists respecting disinterestedness is unmeaning rant, and that when we call upon mankind to divest themselves of self and personal considerations, we call upon them for something which they are not able to practise. We may, with the consistency of truth, have a nobler view of our species; and we may ourselves hold up, as the object of our steady exertions, that state of mind, in which to perceive the practicable means of promoting the good of others, and to employ them, will be invariably associated, without any connecting intervening bond of union.—On the other hand, let no one less highly value the exertions of disinterestedness because it can be shewn to arise from a meaner origin. Ought we not rather to admire the height which has been gained by a steady use of the general means of worth, and by a right employment of the discipline of Providence? Is his conduct less lovely, who has gone through the trial, and brought from it disinterestedness, which prompts to efforts of the noblest kind for the good of others? The original disinterestedness of the mind may be pleasing in some points of view; but in others it is the contrary: it diminishes the worth of character in those cases where it exists, for constitutional disinterestedness has no more merit than the possession of a good sight; and it damps too the efforts to obtain disinterestedness. Those who find themselves deficient, who discover feelings which disinterestedness owns not, have, on the theory here proposed, the best encouragement, the prospect of success, in their endeavours to transfer their affections from self. It leads too, humbly and gratefully, to acquiesce in every means which Providence may appoint, to discipline the mind, and to purify it from all that can debase. In short, it points the view to the highest excellence, and directs the means of attaining it.

4. *Habitual Biases.*

48. We now proceed to the last of those laws of association, which we propose to notice, and in what we shall advance on the subject, we shall make a free use of Stewart's Elements.—The leading feature of the operations of the associative power is, that when two or more ideas, &c. are presented to the mind together, or in close succession, they become con-

nected with one another, or blended together, so that the one when recalled to the view of the mind, is accompanied with the other. But we must not limit its exercise to this operation; it not only connects ideas when they are thus presented together to the mind, but is the cause of the introduction of ideas with one another, which have never before been presented together to the mind. An object which has never before been presented to the mind, may excite numerous ideas, or trains of ideas; while another may continually occur without exciting a single idea And the same object will affect different persons differently, so that in the mind of one it will excite trains of thought, while in another it will only produce a momentary impression; and in different persons too the same object will excite different trains of thought; and in the same person, at different times, different effects will be produced.—Now all this depends upon the habitual or accidental biases to particular kinds of connection, produced either by the habitual tendency of the mental constitution, or more usually, by the particular culture of the individual mind, owing to direct instruction, or to the effect of circumstances, operating without any intention either on his part or on that of others.

49. The earliest bond of union between objects of thought, is their being presented to the mind together, or in close succession, through the medium of sensation; this is owing to the objects of sensation being connected either in time or place, or in other words, owing to the relation of contiguity in time and place existing between these objects. This cause of connection among our ideas is what necessarily has the earliest efficacy in forming those connections, because it does not presuppose, as every other does, the existence of other ideas in the mind, or the exercise of attention to other relations which exist among them. Children associate ideas together almost entirely by this bond of union; persons of uncultivated minds, in the same manner, usually have their ideas connected by the same bond of union, contiguity of time and place of the objects of sensation, producing impressions on the mind at the same time, or in close succession; and more or less it is a connecting link, or cause of connection, in every one, in every period of life. We might, *á priori*, calculate upon its high importance in the mental structure, and as a matter of fact, it is the foundation of all experience and philosophy, and at the same time the source of numerous prejudices. It is the source of numerous prejudices, by leading us to expect continued conjunction in time or place, where the conjunction was only occasional, and thus to suppose a real and permanent connection between objects which had only an accidental and temporary connection. Hence unenlightened experience of the past will fill the mind, in numberless instances, with vain expectations, or with groundless alarms concerning the future; hence the regard which is paid to unlucky days, to unlucky colours, to the influence of the planets, &c.; apprehensions which render human life, to many, a continual series of absurd terrors. But this principle of connection among our ideas is also the foundation of all experience and philosophy; for the grand object of philophy is the knowledge of those laws which regulate the succession of events, so that from the past we may be enabled to anticipate the probable course of the future, and to regulate our conduct accordingly; and therefore it is of the first importance that the connections of time and place should have a strong power over the mind. Experience is of a more limited nature, but has the same object to anticipate the probable course of events, so as to make the past subservient to the conduct of the future; and by rendering contiguity, in time, one of the strongest principles of connection in our minds: the wise Author of our frame has conjoined in our thoughts the same events which we find conjoined in our experience, and has thus accommodated (without any effort on our part) the order of our ideas to that scene in which we are destined to act.

50. Upon the connections established by this principle, all other connections are founded. Some of the most striking are those which arise from the relations of similarity, of contrariety, of cause and effect, of means and end, of premises and conclusion. Next to the relation of contiguity in time and place, that of similarity is most universally operative. It does not depend upon an active exertion of intellect, but arises spontaneously from the mental constitution. Similarity implies partial identity of sensation, and hence an object, when first presented to the mind, frequently recals the idea of that which has some parts of its component sensations the same. Thus when we see a face which considerably interests us, we are often led to recollect the face of some other person, in consequence of the impressions from each agreeing in

some particulars. In the same manner, where the circumstances of one event are, in some respects, the same with the circumstances of another, which had before fallen under our notice, so far there is a recurrence of the same impressions, and that by the more general law of association recals the remaining circumstances.—This cause of connection among our ideas, like that of contiguity in time or place, is of the greatest importance, and at the same time liable to be greatly misused. Without it the experience of the past would be of no utility to us, for the same set of circumstances never occurs twice; if there be sufficient similarity to recal the past, it now answers the purpose of exciting the expectations of what occurred in similar circumstances, that is, of bringing the experience of the past to bear upon the present. But as similarity is only partial sameness, if it be not accompanied with some discrimination, consequences will be expected that will never happen, and conclusions, which will mislead, will be formed without any just foundation.—Ideas are connected together not only in consequence of similarity, that is, sameness in some of their component parts, but frequently also from similarity in the sounds expressing them. It is upon this circumstance that the art of punning is founded; an art which may be innocent in itself considered, but which, when made an object of the mind, leads from sense to sound, and prevents us from carefully examining the arguments and differences of things, on which alone reasoning can be founded. So much, indeed, is a habit of punning at variance with habits of thought and sober reflection, that the whole current of thought will sometimes be diverted from its proper channel, by some word in which the thought is expressed, recalling, by similarity of sound, some other which calls up its own train of thought. A good pun may sometimes be considered as an exercise of the judgment; but more usually it is merely an exercise of the associative power; in this particular principle of connection, similarity in sound; and therefore it would be wise in young persons to check the desire to obtain an acquisition which is of little value, because almost every one may acquire it, and which must check the culture of other more valuable principles of association.

51. Another fertile principle of connection is contrariety, which connects together ideas which are totally, or in many respects opposite to each other. This, however, is more the result of attention and habit than those of contiguity in time or place, and similarity. Some persons are particularly disposed to it, others have little tendency to it. It frequently appears to arise from the natural tendency of the mind to change from one set of feelings, which are in some way or other displeasing, to others which may be pleasing; and very often serves to illustrate reasoning; but particularly to give interest and force to a description of natural scenery, or a delineation of character.

52. The other principles of connection which we mentioned are more refined, and are the result of culture. A person who has been more accustomed to philosophize, or to reason, than to follow the airy flights of wit or poetic fancy, connects his ideas by the principles of cause and effect, of means and end, of premises and conclusion. When a phenomenon is stated to his mind, it almost involuntarily brings forward ideas which serve to account for the phenomenon: we do not mean, that the mind invariably brings forward the right ideas, but simply those which answer the wants of the individual, by serving to account to him for the phenomenon. So, in the same manner, when an end is proposed, the train of thought is concerned about the means, which are often suggested, though the object itself was never before in the view of the mind. All these relations doubtless produce their effect by minute and almost imperceptible samenesses in the particular object now in the view of the mind, and some one which before has been, and has been connected by some cause or other with the cause or means by which it was produced, or to be produced; but it is convenient to speak of them as distinct from the more obvious relations, because they imply different culture of the mind, and lead to such widely different effects.—Now any one of these connecting principles may, by habit, be strengthened to such a degree as to give us a command over all the different ideas in our mind which have the given relation to each other; so that when any one in the class occurs to us, we have almost a certainty that it will suggest the rest.—As this appears to be an indisputable fact respecting the influence of association, we may state it in the following general form:—When an idea is presented to the mind, either by sensation or by association, bearing certain

relations, either in itself, or in its effects on the mind, with another idea already on the mind, the latter is recalled by the former, and becomes connected with it: and the association thus produced is subject to the same laws with those formed, owing to the contiguity in the times of the reception of the ideas.

RESPECTING THE COMPOSITION OF IDEAS.

53. Another grand law, or mode of operation, of the associative power is that by which simple ideas are formed into compound, or complex ideas; in other words, more generally, by which simple sensorial changes are combined and blended together.—In the consideration of this law, we shall derive most of our statements from those of Hartley, divesting them, however, of those peculiarities of expression, which depend for their correctness upon the truth of the positions, that the medullary substance of the brain is the sensorium, and that sensorial changes are vibrations of the medullary substance. In order to explain this law of association, it is necessary to take a view of the modes in which simple ideas, or ideas of sensation, may be associated.

Case 1. Let the sensation A be often associated with each of the sensations B, C, D, &c.; that is, at certain times with B, at certain other times with C, and so on: it is evident from what has been before stated (§ 21.) that A, when produced alone, will raise *a*, *b*, *c*, *d*, &c. (the simple ideas of sensation corresponding respectively with A, B, C, D, &c,) altogether, and consequently will associate them together. If *a*, *b*, *c*, *d*, &c. are distinct in all their parts, then, in the first instance they will be merely connected, so as to make a group (which may be represented by $a+b+c+d$,) but if they are not distinct in their parts, they more or less run into each other, so as to form a complex cluster, (which may be represented by *abcd*.) Now the more frequently the group $a+b+c+d$, &c. occurs in connection, the more closely the single ideas are united; and unless any one has a peculiar degree of vividness, they will by degrees appear to the mind as one idea; and unless the notice of the mind is particularly directed to the circumstance, that it is composed of parts, it appears as much a single idea as originally each of the parts would have done, if the attention had been directed to them singly. Again, the more the cluster *abcd*, &c. occurs in combination the more completely the parts coalesce, so that by degrees they form a complex idea, the parts of which are scarcely distinguishable.

54. Case 2. If the sensations A, B, C, D, &c. be associated together, according to various combinations of twos, or even of threes, fours, &c. then will A raise up $b+c+d$, &c.; also B will raise up $a+c+d$, &c.; and compound or complex ideas will be formed of those combinations, precisely as was before stated in the case of sensations singly associated with another sensation. It may happen indeed in both cases, that A may raise a particular idea, as *b*, preferably to any of the rest, in consequence of its being more frequently associated with *b*, or of the greater novelty of the impression of the corresponding sensation, B, rendering it more vivid, or of some tendency of the sensorium to excite *b*, or of some other cause; and in like manner that B may raise *c* or *d* preferably to the rest. However, all this will at last be over-ruled by the recurrence of the associations, so that any one of the sensations will excite the ideas of the rest at the same instant, and therefore associate them together.

55. Case 3. Let A, B, C, D, &c. represent succcessive sensations (occurring in contiguous, successive instants,) A will raise *b*, *c*, *d*, &c. B will raise *c*, *d*, &c.: and though the ideas do not rise precisely in the same instant, yet they come nearer and nearer together than the sensations did in their original impression; so that these ideas are at last associated synchronously, as they were from the first successively.

56. Case 4. All compound impressions, A + B + C + D, &c. or A B C D, &c. (according as they are received by different organs, or the same) after sufficient repetition, leave behind their compound ideas $a+b+c+d$, &c. or *abcd*, &c which recur every now and then by means of sensations, or ideas, with which the whole compound, or any one or more of the parts, A, B, C, D, &c. have been associated. Now in these recurrences of compound ideas, the parts are further associated, and more intimately united to one another, agreeably to what was observed above, so as to form a compound or complex idea, which shall appear to the mind as one single idea.—As the same causes produce the recurrence of the compounded ideas in whatsoever way the union was first produced, the same remark may be made under each of the cases as have been under this and

the first case, respecting the causes and effects of such recurrence.

57. On the whole it may appear to the reader, that the simple ideas of sensation must run into clusters and combinations, by association; and that each of these will, at last, coalesce into one compound or complex idea. It appears also from observation, that many of our mental or intellectual ideas (that is, those in which no particular idea of sensation is perceptible) such as those which belong to the heads of beauty, honour, moral qualities, &c. are, in fact, thus composed of parts, which by degrees coalesce into one complex idea. And as this coalescence of simple into complex ideas is thus evinced, both by the theory of association and by observation, so it may be illustrated and further confirmed, by the similar coalescence of letters into syllables and words, in which association is likewise a chief instrument.

58. If the number of simple ideas which compose the complex idea be very great, it may happen that the complex ideas shall not appear to bear any relation to its component parts, nor to the external senses by which the original sensations were received. The reason of this is, that each single idea is overpowered by the sum of all the rest, as soon as they are all intimately united together. Thus in very compound medicines, the several tastes and flavours of the separate ingredients are lost and overpowered by the complex one of the whole mass: so that this has a taste and flavour of its own, which appears to be simple and original. Thus also white appears, and is vulgarly thought to be, the simplest of all colours, while yet it really arises from a certain mixture of the seven primary colours in their due shades and proportions. And to resume the illustration above-mentioned, to one unacquainted with the arts of reading and writing, it could not appear probable, that the great variety of complex sounds in language are to be analysed into a few simple sounds. One may hope, therefore, that by pursuing and perfecting the doctrine of association, we may some time or other be enabled to analyse all that vast variety of complex ideas which pass under the names of ideas of reflection, abstract ideas, desires, affections, &c. into their simple component parts, that is, into the simple ideas of sensation of which they are formed. This would be greatly analogous to the representation of complex articulate sounds by alphabetical signs, and to the revolution of colours, or of natural bodies, into their simple constituent parts. The complex ideas here spoken of are generally excited by words or visible objects; but they are also connected with other external impressions, and depend upon them as symbols. In whatever way we consider them, the trains of them which are presented to the mind seem to depend upon the then present state of the body, the external impressions and the remaining influence of prior impressions and associations taken together.

59. As simple ideas of sensation run into complex ones by association, so complex ideas run into decomplex ones by association. But here the varieties of the associations, which increase with the complexity, hinder particular ones from being so close and permanent between the complex parts of decomplex ideas, as between the simple parts of complex ones.

60. The simple ideas of sensation are not all equally and uniformly concerned in forming complex and decomplex ideas, but, on the contrary, some occur much oftener than others; and the same holds good of complex ideas as the component parts of decomplex ideas: and innumerable combinations never occur at all in real life, and consequently are never associated into complex and decomplex ideas. Just as in languages, some letters, and combinations of letters, occur much more frequently than others, and some combinations never occur at all.—Further, as persons who speak the same language have, however, a different use and extent of words, so, though mankind in all ages and nations agree, in general, in their complex and decomplex ideas, yet there are many particular differences in them, and these differences are greater or less, according to the difference or resemblance in age, constitution, education, profession, country, period, &c. that is, in their impressions and associations.

61. When sensations and ideas, with their most common combinations, have been often presented to the mind, a train of them, of considerable length, may, by once occurring, produce such a tendency to recurrence, that they may recur, without the previous cause, in nearly the same order and proportion as in this single occurrence. For since each of the particular sensations and ideas is familiar, little more will be wanting for their recurrency than a few connecting links: and even these may, in some instances, be supplied by former similar instances. These considerations, when duly unfolded, seem to explain the chief phenomena of memory; and it will be easily seen from them, that

the memory of adults, and of proficients in any science, ought to be much more ready and certain than that of children and novices, as it is found to be in fact.

62. As many words have complex ideas annexed to them, so sentences, which are collections of words, have collections of complex ideas, that is, have decomplex ideas. And it happens in most cases, that the decomplex idea belonging to any sentence, is not compounded merely to the complex ideas belonging to the words of it; but that there are also many variations, some oppositions, and numberless additions. Thus propositions, in particular, excite, as soon as heard, assent or dissent; which assent or dissent consist chiefly of additional complex ideas not included in the terms of the proposition. And it would be of the greatest use both in the sciences and in common life, thoroughly to analyse this matter, to show in what manner, and by what steps, that is, by what impressions and associations our assent and dissent, both in scientifical and moral subjects, is formed.

Respecting the Vividness of complex Ideas, and the intellectual Pleasures and Pains in general.

63. It is reasonable to think, that some ideas may be as vivid as any sensation excited by the direct action of objects upon the external organs of sense. For complex ideas may consist of so many parts, and these may so alter and exalt one another, that the sensorial change (whatever that be), may be as great as can be produced by any single external impression. And we know, as a matter of fact, that mental pains are sometimes so acute as to counterbalance, and even altogether remove, the attention from the most excruciating pain, which is merely that of sensation. This process may be assisted and accelerated by the mixture of vivid sensations among the ideas, by the sensibility of the mental frame, by a predisposition to a particular class of ideas, &c.—It is on this principle, in connection with the preceding statement, that we are enabled to account for the existence of intellectual or mental pleasures and pains (that is, those in which no particular sensible pleasure or pain is perceptible), which form a distinct and a most important class of feelings. The quality of sensible pleasures or pains, that is, of pleasurable or painful sensations, unite and coalesce in the same manner as other ideas; and variously connected and blended together, they constitute the whole of those internal feelings which we call passions, affections, emotions, &c.—In almost every step of our investigations in mental philosophy, we are perplexed by the scantiness of language, and still more by the want of precision with which the words we have are employed. It is much more easy to point out faults than to correct them; but it appears to us likely to promote the object in one department, if the two classes of ideas (the relicts of sensations), *viz.* those which are pleasureable or painful, and those which are indifferent, or, more properly, which belong to the understanding, were denominated, the latter notions, the former feelings. Popular language would, in a great measure, have borne us out in this appropriation; but, at least in the commencement of our statements, we were obliged to employ feelings in a more general sense, *viz.* for every sensorial change attended with consciousness, because we have no other word in the language comprehending ideas and sensations: henceforwards, however, we wish to appropriate the word feelings to those complex ideas which are either pleasureable or painful, so as to correspond with Hartley's denomination "intellectual or mental pleasures and pains," including, as he appears to do, the affections and passions.

64. It appears from the preceding section, that the mental pleasures and pains may be equal to, or greater or less than, the sensible ones, according as each person unites more or fewer, more vivid or more languid ideas in the formation of the mental pleasures and pains.

65. It is of the utmost consequence to morality and religion, that the feelings should be analyzed into their simple component parts, by reversing the steps of the associations which concur to form them. For thus we may learn how to cherish and improve good ones, to check and root out such as are mischievous and immoral, and how to suit our manner of life, in some tolerable measure, to our intellectual and religious wants. And as this holds, in respect of persons of all ages, so it is particularly true and worthy of consideration in respect of children and youth. The world is, indeed, sufficiently stocked with general precepts for this purpose, grounded on experience; and whosoever will follow these faithfully may expect good general success. However, the doctrine of association, when traced up to the first rudiments of understanding and affection, unfolds such a scene as cannot fail both to instruct and

alarm all such as have any degree of interested concern for themselves, or of a benevolent one for others.

66. Our original bodily structure, and the impressions and associations which affect us in passing through life, are so much alike, and yet not the same, that there must be both a great general resemblance among mankind in respect of their mental pleasures and pains, and also many particular differences.

67. Some degree of spirituality (that is, that state of mind in which the pleasures and pains are not sensible), is the necessary consequence of passsing through life. The sensible pleasures and pains must be transferred by association more and more every day, upon things which of themselves afford neither pleasure nor pain.

68. Let the letters *a*, *b*, *c*, *d*, *e*, &c. represent the sensible pleasures, and *x*, *y*, and *z*, the sensible pains, supposing them to be only three in number; and let us suppose all these, both pleasures and pains, to be equal to each in degree. If now the ideas of these sensible pleasures and pains be associated together, according to all the possible varieties, in order to form intellectual pleasures and pains, it is plain, that pleasure must prevail in all the combinations of seven or more letters; and also, that when the several parts of these complex pleasures are sufficiently blended by association, the pains which enter into their composition will no longer be distinguished separately, but the resulting mixed and complex pleasures will appear to be pure and simple ones, equal in quantity to the excess of pleasure above pain, in each combination. Thus association would convert a state in which pleasure and pain are both perceived by turns, into one in which pure pleasure would alone be perceived; at least would cause the beings who were under its influence to any indefinite degree, to approach to this last state nearer than by any definite distance. Now, though the circumstances of mankind are not the same with those here supposed, yet they bear a great resemblance to them, during that part of our existence which is exposed to our observation; for our sensible pleasures are far more numerous than our sensible pains; and though the pains are in general greater than the pleasures, yet the sum total of the latter is probably greater than that of the former; whence the remainder, after the destruction of the pains by the opposite and equal pleasures, will be pure pleasure.

69. The intellectual pleasures and pains are as real as the sensible ones, being, in fact, nothing but the sensible pleasures and pains variously mixed and blended together. They are also all equally of a factitious and acquired nature; and we must therefore estimate all of the pleasures equally, by their magnitude, permanency, and tendency to produce others; and the pains in like manner.

Of the Affections and Passions.

70. Affections, passions, and emotions, may be considered as the re-action of the mind towards those objects which directly, or indirectly, produce pleasure or pain. Supposing that by association a very complex, pleasurable feeling has been so connected with any object, as to be excited by the sensation or idea of that object; by degrees the object is considered as the source of that feeling, and the pleasurable feeling blended with the idea of the object, being the indirect or immediate source of it, is called love; the contrary feeling, produced by contrary associations, is called hatred. (We do not here speak of the particular modifications of these feelings, or of their restrictions, but of the general feelings excited in our minds by objects causing, or supposed to cause, pleasurable or painful feeling). When either of them, (the love, for instance,) is habitually connected with any object, it is called an affection for that object; and all its various modifications, however, and in whatever degree produced, if they are more than the ebullitions of the moment, being permanent feelings ready to be excited by the appropriate object in appropriate situations, are also termed affections. If from any strength in the exciting cause, or peculiar sensibility of the frame, or peculiarly vivid associations, connected with objects of a specific cast, that cause or produce a vivid excitement of feeling, which (though it may last perhaps for a considerable time, if not excessive in degree), gradually loses its vividness, and altogether ceases, or settles down into a more permanent, but less active feeling, that vivid, vigorous feeling is denominated a passion. The mind may have such a predisposition to a certain set of passsions, that these may be easily excited, and by every such excitement increase the pre-

disposition to future excitement, and add to the strength and vividness of the more permanent corresponding affections, but the excitement itself, and its effect, the passion, cannot, from the nature of the mind, last long. From this account it may appear, that the passions and affections differ from each other principally in their degree and duration. There is a third class of feelings, which may more properly be called emotions, than either passions or affections; where the pleasurable or painful feelings are not explicitly referred to the exciting cause, and have not that vividness and strength which is essential to a passion, they are states of pleasure or of pain, following the excitement of some affection, and generally accompanied or blended with trains of conceptions and thoughts. We are aware that we do not use this term in the sense in which Dr. Cogan professes to employ it; but we doubt, whether in this instance the usual penetration and accuracy of that philosopher have accompanied him; and as it appears to us, his own use of it is essentially different from that given in his definition, in which he confines it "to the external marks or visible changes produced by the impetus of the passions upon the corporeal system." A tendency to the exercise of affections, and to the excitement of emotions or passions, is called a disposition: in those cases in which the disposition is habitual, and regulates a considerable proportion of the affections or passions, it seems appropriately termed the temper.

71. Respecting the classes of affections, passions, and emotions, we must not here enlarge. It is a most copious and difficult subject; and, as pursued with different objects, different classifications appear preferable. Supposing the object to be, to take these feelings as they are, and to arrange them so as to show their relationship, and tendency to affect one another, having in view the phenomena rather than the causes of them, we should be led to give a decided preference to the elegant arrangement of Dr. Cogan, in his very valuable work on the passions; but if it be to trace them to their sources, in order to show how they are formed, directly or indirectly, of the relics of sensations, and modified by the various combinations of them, which is an object of the greatest importance, as has been already observed, Dr. Hartley's arrangement, even if somewhat deficient in philosophical accuracy, as perhaps Dr. Cogan has shown, must have the preference, having been founded on that object. The arrangement of Dr. Cogan is by himself stated as follows: "When the nature of the exciting cause is more accurately ascertained, it will be found to respect either the selfish or the social principle. Hence arise two important distinctions, forming two different classes. In each class, the predominant idea of a good, and the predominent idea of an evil, will constitute two different orders. The leading passions and affections under each order, point out the genera. The complicated nature of some of the passions, and other contingent circumstances, may be considered species and varieties under each characteristic genus." Dr. Hartley's arrangement is two-fold: first, the passions and affections in general; secondly, the passions and affections, as excited by the different classes of intellectual pleasures and pains. Respecting the latter, we shall have an opportunity of speaking under the different classes: we shall here briefly state the arrangement of the general passions and affections. As all the passions and affections arise from pleasure and pain, the first and most general distribution is into love and hatred. When these are excited to a certain degree, they stimulate us to action, and may then be termed desire, or aversion, understanding by the last word, active hatred. Hope and fear arise from the probability or uncertainty of obtaining the good desired, or of avoiding the evil shunned. Joy and grief are love or hatred exerted towards an object when present, so as to occupy the whole attention of the mind. After the actual joy or grief is over, and the object withdrawn, there generally remains a pleasing or displeasing recollection, which recurs with every recurrence of the idea of the object, or of the associated ones, and keeps up the love or hatred. These ten, five grateful, and five ungrateful, passions or affections, Dr. Hartley considers as comprehending all the general passions of human nature.

OF THE CLASSES OF INTELLECTUAL PLEASURES AND PAINS, WITH A SPECIFIC ACCOUNT OF THEIR ORIGIN.

72. The intellectual pleasures and pains are arranged by Hartley in six classes. Perhaps the arrangement, and certainly the appellations of the classes, are not unexceptionable; but so much light

is thrown upon this part of our mental structure by the analysis of them given by Hartley, and it is so much easier to find fault than to improve, that we shall probably do best by taking the arrangement and (with a few passing remarks) the appellations as we find them, and by laying before our readers such a specimen of the analytical investigations of that profound philosopber, as may lay a solid foundation for correct notions on this important point, and lead them to seek for further information in his observations. The intellectual pleasures and pains are, 1. Those of imagination, arising from natural or artificial beauty or deformity. 2. Those of ambition, arising from the opinions of others concerning us. 3. Those of self-interest, arising from the possession or want of the means of happiness, and security from, or subjection to, the hazards of misery. 4. Those of sympathy, arising from the pleasures and pains of others. 5. Those of theopathy, arising from the consideration of the attributes of the Deity, and the relation in which we stand to him; and, 6. Those of the moral sense, arising from the contemplation of moral beauty and deformity.

1. *Of the Pleasures and Pains of Imagination.*

73. This class of feelings may be distinguished into seven kinds: the pleasures arising from the beauty of the natural world; those from the works of art; from the liberal arts of music, painting, and poetry; from the sciences; from the beauty of the person; from wit and humour; and the pains which arise from gross absurdity, inconsistency, or deformity As the pleasures of the first class admit of the most simple analysis, we shall select this as a specimen. The pleasant tastes and smells, and the fine colours of fruits and flowers, the melody of birds, and the grateful warmth or coolness of the air in the proper seasons, transfer the relics of these pleasures upon rural scenes, which rise up instantaneously so mixed with each other, and with such as will immediately be enumerated, as to be separately indiscernible. If there be any object in the scene calculated to excite fear and horror, the nascent ideas of these magnify and enliven all the other ideas, and by degrees pass into pleasures, by suggesting the security from pain. In like manner the grandeur of some scenes, and the novelty of others, by exciting surprise and wonder (that is, by making a great difference in the preceding and subsequent states of mind, so as to border upon or even enter into the limits of pain) may greatly enhance the pleasure. Uniformity and variety, in conjunction, are also principal sources of the pleasures of beauty, being made so partly by their association with the beauties of nature, partly by that with the works of art, and with the many conveniencies which we derive from the uniformity and variety of the works of nature and of art: they must therefore transfer part of the lustre borrowed from the works of nature, and from the conveniencies they afford upon the works of nature. Poetry and painting are much employed in setting forth the beauties of the natural world, at the same time that they afford us a high degree of pleasure from other sources: hence they blend some or other of the relics of those other pleasures with those of natural beauty. The many amusements which are peculiar to the country, and whose ideas and pleasures are revived in a faint degree by the view of rural scenes, and so mixed together as to be separately indiscernible, further augment the pleasures suggested by the beauties of nature. To these we may add the opposition between the offensiveness, dangers, and corruption of populous cities, and the health, tranquillity, and innocence, which the actual view or the mental contemplation of rural scenes introduces; and the pleasures of sociality and affection, which have many connections with them; and those pleasures which the opinions and encomiums of others respecting natural beauties produce in us, in this, as in other cases, by means of the contagiousness observable in mental, as well as in bodily dispositions. It is also to be remarked, that green, which is the most agreeable to the organ of sight, is the most general colour of the vegetable kingdom, that is, of external nature; but at the same time with so many varieties, that it loses little or none of its effect in producing pleasure, which it would do if it were all of the same tint. Those persons who have already formed high ideas of the power, knowledge, and goodness of the Author of nature, with suitable affections, generally feel the exalted pleasures of devotion upon every view and contemplation of his works, either in an explicit and distinct manner, or in a more secret and implicit one: hence part of the general indeterminate pleasures here considered is deducible from the pleasures of theopathy.

74. The above may be considered as the principal sources of the beauties of nature to mankind in general. Inquisitive and philosophical persons have some others, arising from their peculiar knowledge and study of natural history, astronomy, and philosophy in general: for the profusion of beauties, uses, fitnesses, elegance in minute things, and magnificence in great ones, exceed all bounds of imagination; and new scenes, and those of unbounded extent, separately considered, ever present themselves to view, the more any one studies and contemplates the works of God. Upon the whole the reader may see that there are sufficient sources for all those pleasures of imagination which the beauties of nature excite in different persons; and that the differences which are, in this respect, found in different persons, are sufficiently analogous to the differences of their situations in life, and of the consequent associations formed in them. Those who are closely attentive to what passes within them, may also, when contemplating the beauties of nature, frequently discern the relicts of many of the particular pleasures here enumerated, while they recur in a separate state, and before they coalesce with the general indeterminate aggregate, and this verifies the account here given. It is also a confirmation of it, that an attentive person may observe great differences in the kind and degree of the relish which he has for the beauties of nature in different periods of his life; especially as the kind and degree will be found to agree in the main with the foregoing account. To the same purpose it may be observed, that these pleasures do not cloy very soon, but are of a lasting nature when compared with the sensible ones; since this follows naturally from the great variety of their sources, and the evanescent nature of their constituent parts.

2. *Of the Pleasures and Pains of Ambition.*

75. The opinions of others concerning us, when expressed by corresponding words or actions, are principal sources of happiness or misery. The pleasures of this kind are usually referred to the head of honour, the pains to that of shame. We are here to inquire by what associations it is brought about, that men are solicitous to have certain particulars concerning themselves made known to the circle of their friends and acquaintance, or to the world in general; and certain others concealed from them: and also, why all indications that these kinds of particulars are made known, so as to produce approbation, esteem, praise, &c. or dislike, censure, contempt, &c. occasion such exquisite pleasures as those of honour and shame. These particulars may be classed under four heads: external advantages or disadvantages; bodily perfections and imperfections; intellectual accomplishments and defects; moral ones, that is, virtue or vice. We shall, as before, select the analysis of one of these classes of the feelings of ambition.

76. The intellectual accomplishments and defects which occasion the feelings of ambition, are, sagacity, memory, invention, wit, and learning; and their opposites, folly, dulness, and ignorance. Now, it is evident, that independent of the intrinsic value of the former class, and disadvantage of the other, the circumstance of their being made known to others, respectively produces certain privileges and pleasures, or subjects to inconveniencies and pains. It follows, therefore, that every discovery of this kind to others, also every mark of associate of such discovery, will, by association, raise up the relicts of those privileges and pleasures, or inconveniencies and pains respectively; and these being gradually blended together, and united with those with which each repetition of the producing cause is accompanied, afford in each instance a peculiar compound pleasure or pain, which, by the custom of our language, has the word honour or shame respectively connected with it. The general account will apply to each of the four classes of the feelings of ambition; but the feelings of honour or shame connected with this particular class, require a more minute analysis. A great part, perhaps the greatest, is derived from the high-strained encomiums, applauses, and flatteries, paid to talents and learning, and the outrageous ridicule and contempt thrown upon folly and ignorance, in all the discourses and writings of men of genius and literature; these persons being extremely partial to their own excellencies, and carrying the opinion of the world along with them by the force of their abilities and eloquence. It is also to be observed, that in the education of young persons, and especially of boys and young men, great rewards are conferred in consequence of intellectual abilities and attainments, and great punishments follow negligence and ignorance; which rewards and punishments, being respectively associated with the

words expressing praise and censure, and with all their other circumstances, transfer upon praise or censure compound vivid relicts of those pleasures and pains.

77. In like manner, all the kinds of honour and shame, by being expressed in words and symbols which are nearly related to each other, enhance each other; thus, for instance, the caresses which are given to a child when he is dressed in fine clothes, prepare him to be much more affected with the caresses and encomiums bestowed upon him when he has been diligent in getting his lesson: and, indeed, it ought to be remarked, that the words and phrases of the parents, governors, superiors, and attendants, have so great an influence over children, when they first come to the use of language, as instantly to generate an implicit belief, a strong desire, or a high degree of pleasure. Unless very improper treatment has been practised, they have at that early period no suspicions, jealousies, recollections, or expectations, of being deceived or disappointed; and therefore a set of words, expressing pleasure of any kind which they have experienced, put together in almost any manner, will raise up in them a pleasurable state, and the opposite words a painful one. Whence it is easy to see, that the language expressing praise or blame, must instantly form the mere associations connected with the separate words, put them into a state of hope and joy, or of fear and sorrow. And when the foundation is thus laid, praise and blame will keep their influences from the advantages and disadvantages attending them, though the separate words should lose their particular influences, as they manifestly do in our progress through life.

78. The honour and shame arising from intellectual accomplishments, do often, in learned men, after some time, destroy, in a great measure, their sensibility in respect of every other kind of honour and shame; which seems chiefly to arise from their conversing much with books and learned men, so as to have a great part of the pleasures which they receive from such intercourse closely connected with the encomiums on abilities and learning, and to hear all terms of honour applied to them, and the keenest reproach, and the most insolent contempt, cast upon the contrary defects. And, as the pleasures which raillery, ridicule, and satire, afford to the by-standers, are very considerable, so the person who is the object of them, and who begins to be in pain upon the first slight marks of contempt, has this pain much enhanced by the contrast, the exquisiteness of his uneasiness and confusion rising in proportion to the degree of mirth and insolent laughter in the by-standers; so that it happens that very few persons have courage to stand the force of ridicule, but rather subject themselves to considerable bodily pains, to losses, and to the anxiety of a guilty mind, than appear foolish, absurd, singular, or contemptible to the world, or even to persons of whose judgment and abilities they have a low opinion.

Of the Pleasures and Pains of Self-Interest.

79. Self-interest may be distinguished into three kinds: gross self-interest, or the pursuit of the means whereby the pleasures of sensation, imagination, and ambition, are to be obtained, and their pains avoided; refined self-interest, or the explicit, deliberate, seeking for ourselves of the pleasures of sympathy, theopathy, and the moral sense, and a like explicit endeavour to avoid their pains; and, rational self-interest, or the explicit pursuit of our greatest happiness, without any partiality to any particular kind of happiness, or direct or indirect means of happiness.

80. The love of money may be considered as the chief species of gross self-interest; and, in an eminent manner, assists in unfolding the mutual influences of our pleasures and pains, with the factitious nature of our intellectual ones, and the doctrine of association in general, as well as the particular progress, windings, and endless redoublings of self-love. For it is evident, at first sight, that money cannot naturally and originally be the object of our faculties: no child can be supposed to be born with a love of it; yet we see, that some small degrees of this love rise early in infancy; that it generally increases during youth and manhood; and that at last, in some old persons, it so engrosses and absorbs all their passions and pursuits, as that, from being considered as the representative standard, and means of obtaining the commodities which occur in real life, it shall be esteemed the adequate symbol and means of happiness in general, and the thing itself, the sum total of all which is desirable in life. But we have already said so much on the origin and progress of this affection (§ 43), that we shall

only here attend to the checks which, in the course of life, usually prevent the love of money from acquiring that power which, without such restraint, would overcome all the particular desires on which it is founded.

81. First, then, it is checked by the strong desires of young persons, and others, after particular gratifications; for these desires, by overpowering their acquired aversion to part with money, weaken it gradually, and consequently weaken the pleasure of keeping it, and the desire of obtaining it, all which are closely connected together in this view; notwithstanding that the last, *viz.* the desire of obtaining, and consequently (in an inverted order) the pleasure of keeping, and the aversion to part with, are in another view strengthened by the desires of particular pleasures to be purchased by money. And this contrariety of our associations is not only a means of limiting certain passions, but it may be considered as a mark set upon them by the Author of nature, to shew that they ought to be limited even in this life, and that they must ultimately be annihilated, every one in its proper order.—Secondly, the insignificance of riches in warding off death and diseases, and, in many cases, shame and contempt also, and in obtaining the pleasures of religion and the moral sense, and even those of sympathy, ambition, imagination, and sensation, first lessen their value in the estimation of those who reflect, and afterwards assign to them a very low rank among the means of happiness.—Thirdly, the eager pursuit of any other apprehended source of happiness, such as fame, learning, &c. leaves little room in the mind for avarice, or any other foreign end.

82. These considerations not only account for the limitation set to the love of money, but for the various apparent inconsistencies and pecularities observable in it in different individuals. Thus profuseness with respect to sensual and selfish pleasures, is often joined with avarice; covetous persons are often rigidly just in paying as well as in exacting, and are sometimes generous where money is not immediately and apparently concerned; they have also moderate passions in other respects, and for the most part are suspicious, timorous, and complaisant: and the most truly generous, charitable, and even pious persons, are highly frugal, so as to put on the appearance of covetousness, and even sometimes, and in some things, to border upon it. We also see why the love of money must in general grow stronger with age, and especially if the particular gratification, to which the person was most inclined, become insipid or unattainable; why frequent reflections upon money in possession, and the actual viewing of large sums, strengthen the associations by which covetousness is generated: and why children, persons in low life, and indeed most others, are differently affected towards the same sum of money in different forms, gold, silver, notes, &c.

83. The love of money is universally deemed a more selfish passion than the pursuit of the pleasures of imagination, honour, or sympathy; yet all are generated by association from sensible pleasures, having their origin in self: all in their several degrees tend to private happiness; and all are, in certain cases, pursued coolly and deliberately, from the prospect of obtaining private happiness by them. The reasons why the love of money has in so peculiar and decided a manner the shame of selfishness connected with it, appear to be as follow. The pleasures which it produces are nearly, and in general, completely of a solitary nature, and shun participation. As far as money is deemed a mean to the accomplishment of some useful purpose, it ceases to be desired on its own account, and then its pleasing associations are communicable: but the love of money as an end is exclusive to the individual possessor. And in addition to this it is obvious, that in general it is not only confined to the individual, but prevents others from receiving the advantages which it might procure to them. The pleasures of sympathy on the other hand, consist in doing good to others; those of ambition are scarcely attainable in any other way; and those of imagination are both capable of a very extensive communication, and are most perfect when enjoyed in company.—Further, a regard to self frequently recurring must denote a pleasure selfish; so that if any, even of the most generous pleasures, and such as at first sight have no immediate relation to self-interest, be pursued in a cool deliberate way, not from the mere impulse of present inclination, but from the opinion that it will afford pleasure, they must be referred to self-interest. Now money has scarcely any other relation to pleasure than as an evident means; so that after it has acquired the power of pleasing instantaneously, the intermediate

steps and associations must frequently appear; and hence it forces on the mind a more constant reference to its tendency to promote the happiness of the individual possessor. The other pleasures have, in general, a far greater share of indirect associations with previous pleasures, and acquire the power of gratifying, not so much from being the manifest causes of other gratifications, as their most common adjuncts; whereas money is generally the most visible of all the causes.

84. Honour, power, learning, and many other things, are however pursued in part after the same manner, and for the same reasons, as riches, *viz.* from a tacit supposition that the acquisition of every degree of these is treasuring up a proportional degree of happiness, to be produced and enjoyed at pleasure. And the desires of each of these would, in like manner, increase perpetually during life, did they not curb one another by many mutual inconsistencies, or were not all damped by the frequent experience and recollection, that all the means of happiness cease to be so, when the body or mind cease to be disposed in a manner proper for their reception. It is also worthy of observation, that riches, honours, power, learning, and all other things which are considered as means of happiness, become means to each other in a great variety of ways, thus transferring upon each other all the associated pleasures which they collect from other quarters, and approaching nearer and nearer, perpetually, to a perfect similarity and sameness with each other, in the instantaneous pleasures which they afford when pursued and obtained as ends. It appears, likewise, that all aggregates of pleasure thus collected by them all, must, from the structure of our frame, and of the world which surrounds us, be made at last to centre and rest upon Him, who is the inexhaustible fountain of all power, knowledge, goodness, majesty, glory, property, &c.; so that even avarice and ambition are in their respective ways carrying on his benevolent and all-wise designs. And the same thing may be hoped of every other passion and pursuit; one may hope that they all agree and unite in leading to ultimate happiness and perfection. However, they differ greatly in their present consequences, and in their future ones, reaching to certain intervals of time indefinite and unknown to us, and thus becoming good or evil, both naturally and morally, in respect of us and our limited apprehensions, judgments, and anticipations. And yet one may humbly hope, that every thing must be ultimately good, both naturally and morally.

4. *Of the Pleasures and Pains of Sympathy.*

85. The sympathetic affections, or those by which we feel when others feel, may be divided into four classes: those by which we rejoice at the happiness of others, those by which we grieve for their misery, those by which we rejoice at their misery, and those by which we grieve at their happiness. Of the first kind, are sociality, good-will, generosity, and gratitude; of the second, compassion and mercy; of the third, moroseness, anger, revenge, jealousy, cruelty, and malice; and, of the fourth, envy. It is easy to be conceived that association should produce affections of all these four kinds; since, in the intercourses of life, the pleasures and pains of one person are, in various ways, intermixed with, and dependent upon, those of others, so that compounds of their relicts are excited in all the possible ways in which the happiness or misery of one person can be combined with the happiness or misery of another, *viz.* in the four above mentioned. We have already entered so much at length into the rise and progress of the benevolent affections, (§ 41—47.) that we deem it most expedient to give here the analysis of the third class, those by which we rejoice at the misery of others, previously stating Hartley's application of the terms above mentioned. Sociality is the pleasure we take in the company and conversation of others, particularly of our friends and acquaintance. Good-will (or benevolence in its more limited sense) is that pleasing affection which engages us to promote the welfare of others to the best of our power. Generosity is that modification of benevolence which disposes us to forego great pleasures, or to endure great pains for the benefit of others. Gratitude is that modification of benevolence which arises from the past reception of favours, leading to make every practicable return of good to our benefactor. Compassion is the uneasiness which a man feels at the misery of another. Mercy is compassion exercised towards one who has forfeited his title to happiness, or the removal of misery, by some demerit, particularly against ourselves. Moroseness is that disposition which leads us to be dissatisfied with the efforts of others for our comforts, to be displeased

at their innocent enjoyments, and to feel a pleasure in imposing restraints upon their satisfactions. Anger is a sudden start of passion, by which men wish and endeavour harm to others. Revenge prompts to inflict and rejoice in evil, in return for evil real or supposed. Malice deliberately wishes the misery of others. Cruelty disposes men to take delight in inflicting pain, and in contemplating misery. Jealousy arises from the suspicion of a rival in the affections of a person of the other sex. Envy is the disposition by which we consider the good things possessed by others as a diminution of our own happiness, and grieve at their enjoyment of them.

86. Moroseness, peevishness, severity, &c. are most apt to arise in those persons who have some real or imagined superiority over others, which either magnifies their failures of duty, or at least renders the individual very attentive to such failures. Bodily infirmities and frequent disappointments, by making the common intercourses of life insipid, and enhancing small injuries; delicacy and effeminacy, by increasing the sensibility both of body and of mind with respect to pain and uneasiness; luxury, by producing unnatural cravings, which clash not only with the like cravings of others, but also with the common course and conveniencies of life; and, in short, all kinds of selfishness have the same effects upon the temper. The severe scrutiny which persons sincerely penitent for past departures from duty make into their own lives, and the rigid censures which they pass on their own actions, are often found in proud and passionate tempers, to raise such indignation against vice, as breaks out into an undue severity of language and behaviour with respect to others; and this especially, if they seem to themselves to have overcome all great vices, and are not yet arrived at a due sense of the many latent defects still remaining in them. And this is much increased by all opinions which represent the Supreme Being as implacable towards a part of his creatures, and this part as reprobate towards him. By all which we may see, that every thing which makes disagreeable impressions on our minds at the same time that our fellow creatures are present with us, in sensation or in idea, and especially if these be connected by the relation of cause and effect, &c. will in fact produce in us moroseness and peevishness. This follows from the doctrine of association, and is also an evident fact. It is likewise a strong argument for cheerfulness, and the pleasures of innocent moderate mirth.

87. Anger and revenge may be analysed as follows. The appearance, idea, approach, actual attack, &c. of any thing from which a child has received harm, must by the law of association raise in his mind the relict of that harm. The same harm often arises from different causes; and different harms from the same cause: these harms and causes have an affinity with each other: and thus they are variously mixed and blended together; so that a general confused idea of harm, with the uneasy state of the nervous system, and the consequent activity of the parts, are raised up in young children upon certain appearances and circumstances. By degrees, the denials of gratifications, and many intellectual aggregates, with all the signs and tokens of them, raise up a like uneasiness by the law of association. And thus it happens, that when any harm has been received, any gratification denied, or other mental uneasiness occasioned, a long train of associated relicts of painful impressions enhance the displeasing feeling, and continue it much beyond its natural state. This is the nascent state of the passion of anger, in which it is nearly allied to fear, being in the continuance of the same internal feelings, quickened on the one hand by the actual painful or uneasy impression, but on the other moderated by the absence of the apprehension of future danger. By degrees the child learns, from observation and imitation, to use various muscular exertions, words, gestures, &c. in order to ward off or remove the causes of uneasiness or pain, and so goes on multiplying perpetually, by further and further associations, both the occasions of anger and the expressions of it; and, in particular, associates the idea of hurting another, with the apprehension or actual receiving of harm from that other. As men grow up to adult age, and distinguish living creatures from things inanimate, rational and moral agents from irrational ones, they learn to refer effects to their more ultimate causes, and thus their resentment passes from the inanimate instrument to the living agent, especially if this latter be rational and moral. When the moral ideas of just and unjust, right and wrong, merit and demerit, have been acquired, and applied to the actions and circumstances of human life, in the manner to be hereafter described, the internal feelings of this class

have great influence in increasing or moderating our resentment.

88. Cruelty and malice are the genuine and necessary effects of anger indulged and gratified. They are most apt to rise in proud, selfish, and timorous persons, those who conceive highly of their own merits, and of the consequent injustice of all offences against them, and who have an exquisite feeling and apprehension in respect of private gratifications and uneasinesses. The low and unhappy condition of those around him, gives a dignity to a man's own; and the infliction of punishment, or mere suffering, strikes a terror, and so affords security and authority. Add to these, the pleasures arising from gratifying the will, and perhaps some from mere curiosity, and from the rousing an obdurate callous mind to a state of sensibility. Thus we may perceive how nearly one ill passion is related to another; and that it is possible for men to arrive at last at some degree of pure cruelty and malice.

5. *Of the Pleasures and Pains of Theopathy.*

89. In order to form just ideas respecting the origin and nature of the theopathetic affections, it will be desirable to show what associations are formed with the word God, and with the equivalent and related terms and phrases.—Many of the actions and attributes of men are in common language applied to God; and it is probable that children, in their first attempts to decypher the meaning of the word, suppose it to stand for a man whom they have not seen; and their visible conceptions connected with the term will therefore be that of a human form. When they hear or read that God resides in heaven, (that is, according to their conceptions, among the stars), that he made all things, that he sees, hears, knows, and can do all things, vivid ideas, which surprise and agitate the mind, are raised up in it; and if they have made some progress in intellect, they will feel great perplexity in their endeavours to realize such ideas to themselves; and this perplexity will add to the vividness of the ideas, and all together will transfer to the term God, and its equivalent, such secondary ideas as may be referred to the heads of magnificence, astonishment, and reverence. When children hear that God has no visible shape, that he cannot be seen, &c. it adds much to their perplexity and astonishment, and at the same time destroys many of their former ideas; still, however, some visible ideas of the heavens, the throne of God, &c. seem to remain. When a child hears that God is the rewarder of good actions, and the punisher of evil actions, and that the most exquisite future happiness or misery, (described under a great variety of particular emblems) are prepared by him for the good or bad, respectively, he feels strong hopes or fears rise alternately in his mind, according to the judgment which he passes upon his own actions, founded partly upon the previous judgment of others, and partly upon an imperfect moral sense or conscience begun to be produced in his mind. At different periods of this progress, those ideas which have arisen from his filial relation, unite and blend with all the ideas previously connected with the term God, in consequence of the frequent application of the term Father to the Supreme Being; and there cannot be a reasonable doubt, that the notions and feelings which he has formed towards his earthly parents, at first form a considerable share in, and for a long period afterwards tend to modify those belonging to the term God.—On the whole, therefore, it is probable, that among Jews and Christians, children begin with a definite visible conception attached to the word; that this is by degrees obliterated, without any thing of a stable precise nature succeeding in its room; and that by further degrees a great variety of strong mental affections recur in their turns when they think of God.

90. The affections exerted towards God, may be classed under two general heads, love and fear: to the former may be referred gratitude, confidence, and resignation, also enthusiasm, which may be considered as a degeneration of it; to the latter, reverence, (which is a mixture of love and fear) also superstition and atheism, which are degenerations of it.—The love of God, with its related affections, is generated by the contemplation of his bounty and benignity, as these appear from the view of the natural world, the declarations of the Scriptures, or a man's own observation and experience respecting the events of life. It is supported and much increased by the consciousness of upright intentions and sincere endeavours, with the consequent hope of future reward; and by prayer, vocal and mental, public and private, inasmuch as this gives a reality and force to all the ideas before spoken of. Frequent conversation and reading, in which the devout affections are excited, have great efficacy also from the infectious nature of our dis-

positions, and from the perpetual recurrency of the appropriate words, and of their secondary ideas, first in a faint state, afterwards in a stronger and stronger, perpetually. The contemplation of the rest of the divine attributes, His omnipotence, omniscience, eternity, omnipresence, &c. have also a tendency to support and augment the love of God, when this is so far advanced as to be superior to the fear; till then, these wondrous attributes enhance the fear so much, as for a time to check the rise and growth of the love. Even the fear itself greatly contributes to the generation and augmentation of the love, and in a manner greatly analogous to the production of other pleasures from pains. And, indeed, it seems, that notwithstanding the variety of the ideas and feelings, which contribute to this affection, there is so great a resemblance among them, that they must languish by frequent recurrency, till ideas of an opposite nature, by intervening at certain seasons, give them fresh life.—On this theory the love of God is evidently deduced in part from interested motives, directly, *viz.* from the hopes of a future reward; and partly from motives or sources of it, in which direct explicit self-interest does not appear, but which may be traced up to it ultimately. However, after all the sources of this affection have coalesced together, it becomes as disinterested as any other. It appears also that this pure disinterested love of God may, by a concurrence of a sufficient number of sufficiently strong associations, arise to such a height as to prevail over any other of the desires, interested or disinterested.—Enthusiasm may be defined, a mistaken persuasion in any person that he is a peculiar favourite with God, and that he receives supernatural marks thereof. The vividness of the ideas of this class easily generates this false persuasion in persons of strong imaginations, religious ignorance, and narrow understandings, (especially where the moral sense is but imperfectly formed), by giving a reality and certainty to all the reveries of a man's own mind, and confirming the associations in a preternatural manner. It may also be easily contracted by contagion, as daily experience shows; and indeed more easily than most other dispositions, from the lively language used by enthusiasts, and from the great flattery and support which enthusiasm gives to pride and self-conceit.

91. The fear of God arises from a view of the evils of life, the threatenings of the Scriptures, the sense of guilt, the infinity of the divine attributes, and from prayer, meditation, conversation, and reading on such subjects. When confined in proper limits, it is awe, veneration, and reverence; when excessive, or not duly regarded, it degenerates either into superstition or atheism. Superstition may be defined, a mistaken opinion concerning the severity and punishments of God, magnifying them in respect to ourselves or others. Atheism is either speculative, which denies the existence of God; or practical, which is the neglect of Him, where a person thinks of Him seldom, or with reluctance, and pays little or no regard to Him in actions, though he does not deny Him in words. Both kinds, in Christian countries, seem to proceed from an explicit or implicit sense of guilt, and consequent fear of Him, sufficient to generate an aversion to the thoughts of him, and to the methods by which the love might be generated, and yet too feeble to restrain from guilt: and it is the tendency of all pain, to prevent the recurrency of the circumstances which produced it.

6. *Of the Pleasures and Pains of the Moral Sense.*

92. There are certain dispositions of mind, with the actions flowing from them, which when a person believes himself to be possessed of, and reflects upon, a pleasing consciousness and self-approbation rises up in his mind, exclusively of any direct explicit consideration of advantage likely to ensue to himself from his possession of those dispositions: in like manner, the view of them in other persons raises up a disinterested love and esteem for those persons. And the opposite qualities and actions are attended with the condemnation both of ourselves and others. This is in general the state of the case; but there are many particular differences, according to the particular education, disposition, profession, sex, &c. of each person. The general agreement and particular differences in our ideas of right and wrong, and consequent approbation and disapprobation, seem to admit of an analysis and explanation, from the following particulars.

93. First, children are for the most part instructed in the difference and opposition of virtue and vice, and have some general descriptions of the virtues and vices with which they are particularly concerned. They are told that the first are good, pleasant, noble, beautiful, fit, worthy of praise and reward, &c. the last

odious, painful, shameful, worthy of blame, punishment, &c. So that the painful and displeasing associations previously annexed to those words in their minds, are, by means of that confidence which they place in their parents and instructors, transferred to the virtues and vices respectively. And the mutual intercourses of life have the same effect in a less degree, with respect to adults and those children who receive little or no instruction from others directly. Virtue is in general approved and set off with all the encomiums and honourable appellations which any other thing admits of; and vice loaded with censure and reproaches of all kinds, in all good conversation and books. And this happens oftener than the contrary, even in bad ones. So that, as far as men are influenced in their judgments by those of others, the balance is on the whole on the side of virtue.

94. Secondly, there are many immediate good consequences which attend upon virtue, and many ill consequences upon vice, and this during the whole progress of our lives. Sensuality and intemperance subject men to diseases and pain, to shame and anxiety: temperance is attended with ease of body, freedom of spirits, the capacity of being pleased with the objects of pleasure, the good opinion of others, the perfection of the senses and of the mental and corporeal faculties, &c. Anger, malice, and envy, bring returns of anger, malice, and envy from others, with injuries, reproaches, fears and perpetual disquietudes; and in like manner good-will, generosity, compassion, are rewarded with suitable returns, with the pleasures of sociality and friendship, and with high encomiums. And when a person, by the previous love of man, is qualified to worship God in any measure as he ought, this affords the sincerest joy and comfort; while, on the contrary, the neglect of God, or practical atheism, murmuring against the course of providence, fool-hardy impiety, &c. are evidently attended with great anxiety, gloominess and distraction, as long as any traces of morality or religion are left upon the mind. Now these pleasures and pains are often recurring in various combinations, and being variously transferred upon each other, from the great affinity between the several virtues and their rewards, and the vices and their punishments, will at least produce a general mixed pleasing consciousness, when we reflect upon our own virtuous affections or actions; a sense of guilt and anxiety, when we reflect upon the contrary; and also raise in us the love and esteem of virtue, and the hatred of vice in others.

95. Thirdly, the many benefits which we receive immediately from the piety, benevolence, or temperance of others, or which have some obvious connection with them, and the mischiefs resulting from their vices, lead us to love or hate the persons themselves by association, and then to love and hate the virtues and vices themselves, and this without regard to our own interest, and whether we view them in ourselves or others. The love and esteem of virtue in others is much increased by the pleasing consciousness which our own practice of it affords to the mind: and in like manner the pleasure of this consciousness is much increased by our love of virtue in others.

96. Fourthly, the great suitableness of all the virtues to each other, and to the virtue, order, and perfection of the world, impress a very lovely character upon virtue; the contrary, self-contradiction, deformity, and mischievous tendency of vice, render it odious, and the object of abhorrence to all who reflect on the subject. The terms which are employed to denote the pleasures of the imagination are employed in connection with virtue; and all the associated feelings attached to the terms are consequently associated with virtue, adding greatly, therefore, to the pleasures derived from the contemplation of an act of sublime virtue.

97. Fifthly, the hopes and fears of a future life are themselves pleasures and pains of a higher nature. When a sufficient foundation has been laid by a practical belief of religion, by thoughts of death, by the loss of friends, by corporeal pain, by worldly disappointments and afflictions, for the formation of strong associations of the pleasures of their hopes with duty, and the pains of these fears with sin, the repetition of these associations will at last make duty itself a pleasure, and convert sin into a pain, and give lustre and deformity to all their respective appellations. And these associations will gradually become so strong, that the express recollection of the hopes and fears of another world will vanish from the view of the mind.

98. Sixthly, all meditations upon God, and all the expressions of the feelings of our minds towards Him, by degrees transfer all the perfection, greatness, and glo-

riousness of his natural attributes upon his moral ones, that is, upon moral rectitude. By these means we shall learn to be merciful, holy, and perfect, because God is so; and to love mercy, holiness, and perfection, wherever we see them.

99. Hence it appears that all the pleasures and pains of our nature, those of sensation, imagination, ambition, self-interest, sympathy, and theopathy, as far as they are consistent with each other, with the constitution of our minds, and with the course of the world, produce in us a moral sense, and lead to the love and approbation of virtue, and to the fear and abhorrence of vice. This moral sense, therefore, carries its own authority with it, inasmuch as it is the sum total of all the rest, and the ultimate result from them. When it has advanced to considerable perfection, a person may be made to love and hate, merely because he ought; that is, the pleasures of moral beauty and rectitude, and the pains of moral deformity and unfitness, may be transferred and made to coalesce almost instantaneously.

IV. OF THE MOTIVE POWER.

100. In our general view of the primary mental faculties, we stated as an obvious fact, that 'without any external excitement of the nerves by which muscular motion is produced, the mind can produce such motion; in other words, that state of the motory nerves by which muscular motion is effected, can be produced by the mind.' To account for this fact, we infer that the mind possesses a power or capacity of influencing the motory nerves so as to produce muscular motion, which may be called the motive power.—Even supposing that the sensorial changes by which muscular motion is followed, whatever they may be, are of the same nature by external impressions; and admitting, what appears certain, that the associative power is the cause that ideas, and sometimes that sensations, produce motory changes of the sensorium, still we must infer the existence of a motive power; otherwise ideas and sensations could not be the exciting cause of muscular motion: in other words, whatever be the mental causes of muscular motion, that motion, if it begin from the mind, implies that the mind possesses the power of which we speak, separate from the cause of sensations, of ideas, and of the connections among them. Indeed it appears to be generally admitted, but is usually referred to the head of will.

101. A large class of the phenomena of muscular motion are explicable by the principle of association; and, as far as we perceive, they can be explained only by its laws. There are four classes of muscular motion; 1. Where it is produced by some foreign excitement of the muscular system, without the intervention of the mind, in which case it may be called involuntary; 2. Where it is produced by sensation without volition, or any other associated sensation, idea, or motion, having been concerned in the connection between sensation and motion, in which case it is termed automatic in the Hartleyan nomenclature; 3. Where it follows that state of mind which we term will, directly, and without our perceiving the intervention of another idea, or of any sensation or motion, it may be termed voluntary in the highest sense of this word; 4. Where the motion has been voluntary, but is become automatic by the influence of the associative power, it is termed by Hartley secondarily automatic. With the first of this class of motions, Mental Philosophy has little or nothing to do; as to the second, till more is known respecting the nature of those changes which take place in the sensorium, it can do little more than state the fact. The third and fourth afford farther illustrations of the doctrine of association, and we shall select from the Mental Principia such statements as will suffice to explain the progress of muscular motion from automatic to voluntary, and from voluntary to secondarily automatic.

102. The most simple instance of this progress is in the action of grasping. The fingers of young children bend upon almost every impression which is made on the palm of the hand, thus performing the action of grasping in the original automatic manner. After a sufficientrepetition of the motions which concur in this action, the sensorial changes preceding them are strongly associated with different ideas, the most common of which probably are, those excited by the sight of a favourite plaything or other object which the child is used to grasp and hold in his hand. He ought therefore, according to the doctrine of association, to perform and repeat the action of grasping, upon having such a play-thing, &c. presented to his sight: and it is a known fact that children do so. By pursuing the same method of reasoning, we may

see how, after a sufficient repetition of the proper associations, the sound of the words grasp, take hold, &c. the sight of the nurse's hand in a state of contraction, the conception of a hand in that state, and innumerable other associated circumstances, that is, sensations, ideas, and motions, will produce the action of grasping, till, in consequence of the action of grasping being found to answer certain purposes which are wished for, that state of mind which we may call the will to grasp is generated, and sufficiently associated with the action to produce it instantaneously. It is therefore perfectly voluntary in this case: and by the innumerable repetitions of it in this perfectly voluntary state, it comes, at last, to obtain a sufficient connection with so many sensorial changes, either sensitive, ideal, or motory, that (whether or not they are so vivid or so countenanced by the state of mind as to excite the consciousness,) it follows them in the same manner as originally automatic actions do the corresponding sensations, that is, to be secondarily automatic. And in the same manner may all the actions performed with the hands be explained, all those which are very familiar in life passing from the original automatic state through the several degrees of voluntariness, till they become perfectly voluntary, and then repassing through the same degrees in an inverted order, till they become secondarily automatic on many occasions, though still perfectly voluntary on some occasions, *viz.* whensoever an express act of the will is concerned.—A more interesting though more complicated case is that of the employment of the organs of speech, for which we refer our readers to Hartley's Observations, vol. i. p. 106, or Priestley's Abridgment, p. 33.

103. We may hence understand in what manner the first rudiments are laid of that faculty of imitation which is so observable in young children. They see the actions of their own hands, they hear themselves pronounce. Hence the impressions made by themselves on their own eyes and ears become associated circumstances, and consequently must, in due time, excite to the repetition of the actions. Hence like impressions made on their eyes and ears by others, will have the same effect; or in other words, they will learn to imitate the actions which they see, and the sounds which they hear. —Imitation is a great source of the voluntary power, and makes all the several modes of walking, handling, and speaking, &c. conformable to those of the age and nation in which a person lives, and in particular to those of the persons with whom he converses. Besides the two sources of it just mentioned, it has many others. Some of these are, the resemblance which children observe between their own bodies, with all the functions of them, and those of others; the pleasures which they experience in and by means of all imitative motions; the directions and encouragements given to them on this head; the high opinions which they form of the power and happiness of adults; and their consequent desire to resemble them in these, and in all their associated circumstances. Imitation begins in the several kinds of voluntary actions about the same time, and increases not only by the sources alledged, but also by the mutual influence of every instance of it over every other, so that the velocity of its growth is greatly accelerated for some time. It is of the highest consequence to children in their attainment of accomplishments, bodily and mental. And thus every thing to which mankind have a natural tendency, is learned much sooner in society than the mere natural tendency would produce it; and many things are learned so early, and fixed so deeply, as to appear parts of our nature, though they may be mere derivatives and acquisitions.

OF THE SECONDARY POWERS OF THE MIND.

104. We did not set out with the hope of giving a complete outline of the most extensive subject of this article; but our readers will probably think us unnecessarily deficient, if we say nothing respecting memory, conception, judgment, attention, abstraction, imagination, and will, which in books on the philosophy of the human mind constitute so important a part; and though we think the operation of the associative power of such extent, that separate from mere sensation and retention this ever active principle will furnish a sufficient explanation of all the phenomena of intellect and affection, we agree with Mr. Stewart, that the common classification, having certainly some foundation in nature, should by no means be neglected. We shall accordingly, in the remainder of this article, and in those to which we shall now refer our readers, endeavour to give them such a view of

the secondary faculties as may serve for the purposes which we originally proposed for ourselves. See UNDERSTANDING, or *Judgment*, in which, in connection with the article WORDS, we shall endeavour to lay before our readers a summary view of the highly important principles of Hartley, respecting those phenomena of the human mind which he classes under the head of understanding, or "that faculty by which we contemplate mere sensations and ideas, pursue truth, and assent to, or dissent from, propositions." The passions, affections, pleasures, and pains, are usually referred to the general head of will: respecting them we have already spoken at large. Of the other secondary powers of the mind, we shall here give a very short account, referring our readers to the "Elements of Dugald Stewart," (a work which we earnestly wish to see completed) for various sound and comprehensive views respecting them, mixed, we must confess, with several things in which we cannot agree, but which are so written as to delight even those whom they will not convince. We shall expect a most rapid progress of the Hartleyan philosophy, if the principles of it should ever be detailed in the imposing manner in which Mr. Stewart has given his to the public.

MEMORY.

105. The memory is defined by Hartley to be that faculty by which traces of sensations and ideas recur, or are recalled, in the same order and proportion, accurately or nearly, in which they were once actually presented.—The rudiments of memory are laid in the perpetual recurrency of the same impressions, or groups of impressions. These, by the operations of the retentive power, leave traces or relicts; and by the operation of the associative power, these are united in the order in which they were presented to the mind. Now, the single sensible impressions and small groups of them being few, in comparison of all the large groups, they recur the most frequently, so as sooner to produce the elements of memory.

106. Suppose a person to have so far advanced in life as to have acquired all these elements; that is, that he has ideas of the common appearances and occurrences of life, under a considerable variety of subordinate circumstances, which readily recur to his mind by slight causes, he will be thus easily enabled to retrace other occurrences; for these will consist either of the old impressions variously combined, or of new ones in some way or other connected with them. This may be exemplified and explained by the circumstance, that it is difficult to remember even well-known words which have no connection with each other; and still more so words which are neither familiar, nor formed according to familiar analogies; but that, on the other hand, persons acquainted with any branch of science or of art, very easily retain facts connected with it which were previously unknown.—The recollection of ideas is also greatly aided by the connection of words, both with them and with the original impressions; for words being, from the constant use of language, familiar to persons of moderate mental culture, even in various combinations, they are easily retained, and most materially assist in producing the recurrence of the corresponding ideas. And thus, when a person is relating a past fact, the ideas in some cases suggest the words, and in others, the words suggest the ideas. Hence illiterate persons, other things being equal, do not remember nearly so well as others. Hence also the importance, contrary to the views of education which a few years ago were so fashionable, of teaching the young to remember words as well as things; for in most cases, as words serve as the bond of ideas, ideas will be loose and floating in the mind, unless connected with words.

107. The difference between ideas and sensations principally consists in the greater vividness and distinctness of the latter; but cases are known to occur, in which visual conceptions are so vivid and distinct, that they are mistaken for actual sensations. This is particularly the case when, in consequence of disease, the system is peculiarly susceptible of excitement; and sometimes when the mind is very much absorbed in contemplating its own ideas, so that the impressions from external objects produce little effect upon it. It is a fertile source of those ideas respecting apparitions, which are so prevalent among persons of physical sensibility, without that culture of the intellect, which would enable them to attend to their own thoughts and manner of thinking. Such lively recollections of past impressions may, however, be usually distinguished from sensations, by allowing the attention to relax, so that they may cease to be forcibly detained as objects of consciousness, when it will, in general,

be easily perceived that the mind loses sight of them; whereas it can lose sight of impressions from external objects only by fixing the attention upon ideas, or by corporeal motion of some kind or other. —These remarks might perhaps, with greater propriety, have been made under the head of imagination; because it is seldom that in such cases the vivid conceptions recur in the exact (or nearly exact) order of actual impression, which is the essential difference between the trains of imagination and those of memory: they are, however, referable to either class of phenomena.

109. Ideas of recollection differ from those of the imagination, principally, in the readiness and strength of the associations; but partly, and in many cases almost entirely, by the connection of the former with known and allowed facts, by various methods of reasoning appropriate to the peculiar circumstances of the case, and by recollecting that we had before considered them as recollections, &c. Great difficulty, however, often exists, especially in the minds of persons with vigorous conceptions, who have not been habitually careful to cultivate accuracy of perceptions, and in the relation of recollections, to know whether the trains of ideas presented by the associative power are to be referred to the memory or to the imagination. Such persons, seizing only the outline of a fact or series of occurrences, from habitual inattention to their sensations, are, from readiness of association, able to fill up the transcript, so as to make it appear plausible to themselves; and by once or twice detailing it without minute regard to accuracy, except in those leading features, they give a vigour to the ideas and closeness to the association of them, which leads at last to the full conviction, that the whole is recollected. Cases of this sort are very frequent; and they often leave upon the minds of others the belief, that such persons intentionally depart from truth, whereas sometimes the fact is, that part of their error arises from a desire to give the whole truth, when they have only the materials for a portion of it in their minds. However, the fault is one which should be carefully guarded against; particularly in the early part of life, by making young people of lively imaginations habitually attentive to the minute as well as the leading parts of their impressions.—All persons are at one time or other at a loss to know whether trains of vivid ideas, succeeding each other readily and rapidly, are ideas of recollection or of imagination, that is, mere reveries: and the more they agitate the matter in their minds, the more does the reverie appear like a recollection. Persons of irritable nervous systems are more subject to such fallacies than others; and insane persons often impose upon themselves in this way, *viz.* by the vividness of their ideas and associations, produced by bodily causes. The same things often happen in dreams.

110. The vividness and readiness of recollected trains, is also one grand means of ascertaining the dates of facts; for as this diminishes, (other things being equal), in proportion to the period which has elapsed since the reception of the ideas, and the formation of the associations, if the vigour of these be diminished, we refer them to a more remote period, in proportion to that diminution; and if by any cause it be kept up, the distance of time appears diminished. Thus it is, that if any interesting event, the death of a friend, for instance, have been often recollected and related, till we come to make oral or mental calculations, it appears to have happened but yesterday, as we term it. However, from this circumstance we are often apt to confound events, as to the order of time, refering them to more recent or remote periods, according to the strength and vigour of the ideas and associations, or the contrary. In general we judge of the period of events by associated circumstances, particularly by visible permanent memorials. And hence it happens that illiterate persons have often great difficulty in assigning periods to events with any tolerable accuracy. Our readers, when they take such things into account, and consider how difficult it must in most cases be for illiterate persons, who have frequently changed their employments, to refer such changes to any specific dates, will not feel unwilling to admit, that the presumption formed against the reputed murderers of Steele, in consequence of their incorrect statements as to their places of employment four years before their trial, should have weighed very little in the decision against those unhappy men.

111. We distinguish a new place, person, &c. from one which we remember, in a manner similar to that in which we distinguish between recollected ideas and those of imagination; by the greater vividness of the impression, and the

strength and readiness of the associated circumstances. If we doubt whether we have before seen a person who is newly introduced to us, we try to recal some associated circumstance, such as the time and place where we may be supposed to have seen him; and if this prove erroneous, we immediately infer that our doubt arises from some resemblance which he has with some one whom we then or there saw, or with some one whose face is familiar to us.

112. The memory of children is imperfect, because the elementary rudiments of memory are not sufficiently fixed by the retentive power, nor their usual groups sufficiently formed in the mind. They are also imperfect in the use of those words and other symbols which so materially aid the recollection; and in particular they are found very deficient in arranging facts in the order of time, judging most frequently from the vividness of their recollections, and not having the use of those denotements of time, on which the memory principally depends for accuracy in this branch of recollection. In old persons, whatever be the part of the system on which the retentive power depends, that power is most materially diminished, as also the sensitive power, while the associative power has, in their habitual direction of it, been strengthened in its operations. Hence new impressions can scarcely be received, and seldom are retained; while the parts which are received and retained excite old trains of associations, rather than continue those which were recently impressed. When old persons relate the incidents of their youth with great precision, it is rather owing to the recollection of many preceding recollections and relations, than to the recollection of the thing itself.

113. Memory depends greatly upon the state of the brain. Concussions, and other disorders of the brain, and the use of spirituous liquors, impair it: and it is recovered by degrees,as the causes which affected the brain are removed. In like manner dreams, which happen in a peculiar state of the brain, *viz.* during sleep, vanish as soon as vigilance, a different state, takes place; but if they be recollected immediately upon waking, and thus connected with a state of vigilance, they may be remembered.

114. When a person desires to recollect a thing that has escaped him, suppose the name of a visible object, he recals the visible idea, or some other associate, again and again, by a voluntary power, and thus at last brings in the required association and idea. But if the desire be very great, it changes the state of the brain, and has an opposite effect, so that the desired idea does not recur till all has subsided, perhaps not even then.

115. The excellence of memory consists partly in its strength and accuracy of retention, partly in the readiness of recollection. The former principally depends on the strength and accuracy of perception in attention to our sensations, and partly upon the associative faculty; the latter depends entirely upon the strength and peculiar biases of the operations of that power. The intellectual faculties depend greatly upon the memory: hence, though some persons may have strong memories with weak judgments, yet no man can have a strong judgment with a weak original power of retaining and remembering. Before we conclude our view of this faculty, we beg leave strongly to recommend to our younger readers, especially if they possess a philosophic cast of mind, an attentive perusal of the very useful and interesting chapter of Dugald Stewart on this subject, particularly those parts which relate to the improvement of the memory.

CONCEPTION.

116. We have mentioned this as one of the secondary faculties of the mind, because it is considered as a distinct faculty by Mr. Stewart, whose authority we in many cases respect; and who we suppose has in this instance produced, in many of his admirers, a belief in the justness of his statements, which we think far from well founded. We shall have an opportunity of stating our opinion respecting it under the next head, and shall therefore decline enlarging upon it here.

ATTENTION, ABSTRACTION, AND GENERALIZATION.

117. By investigating the phenomena of mind at a time when we have formed a connection between volition and certain mental states or operations, we are repeatedly led to consider those states or operations, however passive the mind might originally have been, as totally, and in their own nature voluntary.—This is remarkably the case with that state of mind which we call attention. That this is in young children entirely involuntary,

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is apparently certain, and those who are endeavouring to form their minds to habits of study and reflection, know from constant experience that they have it not under their command. So far from having an original power of excluding vivid ideas or sensations, to give our attention to those which, though most certainly demanding it, do not make the same lively impression upon the mind, it is a habit which requires the strictest and severest discipline to produce it; it is a possession honourable, and invaluable, but like every other of importance, not the acquisition of the moment, but of a long continued course of rigorous, and in many cases, of painful exertion. And when the habit of attention is formed, that is, when we can produce the state of mind called attention by a volition, how much may fairly be attributed to the nature of the object, which, though, perhaps, at first uninteresting, becomes pleasing and impressive, and thus produces that state by the original laws of our constitution. It even appears probable that the person who has formed such habits of attention to a particular science, as to be able to give it his undivided attention, would be almost as incapable of directing it to frivolous objects, as to a science to which habitual attention, or the nature of the subject, does not give any charms, as he was when he first entered upon his pursuits. In a word, when we take into consideration the circumstances that our attention is never undivided, except to those things which are calculated to engage it, either by the original agreeableness of their nature, or that which they acquire in proportion as our habits become confirmed, and that the associative faculty may, and in many instances does, form a connection between the mental states we call attention and volition; we have probably then sufficient data to account for the phenomena of attention, without calling in the aid of a new faculty.

118. Abstraction is defined by Mr. Stewart, the faculty by which the mind separates the combinations which are presented to it. This definition, so far as it goes, appears to be very correct; but if the processes of generalization are intended to be contained in it, it is by no means sufficient; as will immediately appear from the slightest consideration of that mental process. Abstraction, in this acceptation, is indeed "essentially subservient to every act of classification:" but by no means comprehends that act in the number of its functions. Though we cannot agree with Mr. Stewart in all his statements in his chapter on attention, we must in this position, that the mind "cannot attend at one and the same instant to objects which we can attend to separately." If this be the case, what is abstraction but attention directed to particular objects, owing either to something vivid in the sensations they excite, or to the frequency of their recurrence? in fact, subject to all the laws of attention, perfectly involuntary in early life, and afterwards becoming, to a certain degree, voluntary, by means of a strong association formed between the states of mind called volition and attention.

119. In speaking of the process of generalization, some observations will apply to the process of abstraction separately considered. We shall therefore proceed to consider the formation of general or abstract notions; a process in which the mind is most usually passive; which seems capable of satisfactory explanation upon the principle of the associative powers, and apparently cannot be explained without it.

120. Sensible objects, and particularly visible, are undoubtedly the first which exercise the power of abstraction, or separate attention, and here the process appears plain. The object makes its appropriate impression upon the organs of sense, and when withdrawn leaves in the mind an idea. Another sensation is received from an object bearing strong features of similarity to the former; by the laws of association it calls up the idea it produced, and becomes associated with it. Other similar objects are presented, and the features in which they agree being the most frequently called up, engage most the attention of the mind, and thus becoming, in some degree, separate from the objects which originally were connected with them, constitute the abstract idea. The readiness with which these circumstances of resemblance recal the idea or conception of the individuals from which they were abstracted, depends upon the habits of the individual, and the number of objects from which the abstract notion was formed. If we had seen but two or three sheep, it is probable that the circumstances of resemblance would be so connected in our minds with the individuals, that one or more of them would be constantly called up when considering the circumstances of resemblance; but if the number be much greater, that is, if the circumstances of resemblance have been frequently in the

mind, particular individuals much less frequently, the notion of these circumstances of resemblance becomes somewhat disjointed from the objects by which it was formed. And though it is probably impossible to have a general idea of any class of objects merely sensible, without the idea of an individual being present in the mind; yet from the causes I have mentioned, the general features of resemblance not being particularly connected with any individual, those features only are strong and vivid, and call the attention of the mind, while all the other circumstances of dissimilarity have no effect upon it, and do not attract its attention.

121. The procedure of the mind appears to be exactly the same, though less obvious, and usually more difficult of analysis, when the general idea is more remote from sensation, when in fact, the notions of the quality, or qualities, even in the individual, may be very complex, and this in proportion, as it is more intellectual and refined.—In the former class of general notions, and even in some instances of the present, where the quality is definite and obvious, it is probable that language would not be requisite for the formation of ideas; indeed, if the above account be just, it cannot be requisite. For the abstraction, so far as it is involuntary, is solely the effect of the frequent recurrence of some particular qualities with which they are occasionally combined. But those abstract ideas in which the circumstances of resemblance between the composing ideas are not very obvious or very distinct, either would not have been formed at all by the bulk of mankind, or at least would have been very confused.—We can go very far with those who contend, that general ideas would not exist in the mind without the medium of language; but that they could not, from any deficiency of mental capacity to form them, does by no means appear certain. The same faculties which now produce them, might have produced them without the powers of communication; and there appears no reason why the deaf and dumb child may not form a general idea of men, or horses, or fire, or any object of a similar kind, as well as if capable of annexing terms to the objects of perception.

122. It can be no objection to this account of the procedure of the mind in generalization, that we are able to form classifications of objects from circumstances which are not calculated to strike the mind of the common observer. When left to itself, before habits of reflection are formed, the mind will be necessarily attracted by the most prominent sensible features of resemblance, and the objects would become associated by that bond of union; and in very many cases this would differ in different individuals; but it is indubitable, that we may acquire such a command over our associations, that we may be able to combine objects in our minds which have no customary tendency to such combination, owing to the laws of association, by a more factitious connection, and that, by the requisite culture of the mind, certain connecting principles are either discovered or confirmed, which could not have been of any force in a more early period of mental progress. In the first of these cases the association is voluntary, and if there were not some apparent benefit resulting from it, or some circumstances calculated to produce it in the mind, it would soon give place to a more natural union. So far, however, as any general idea is formed, its production is accomplished agreeably to the principles we have stated. In the second, the operation of the mind is most usually involuntary; when voluntary, the observations on the first cease to apply.

123. It is obvious that, the fewer and more distinct the circumstances which are comprehended under the general notion of a class of objects, the more clear and definite will be the general notion itself. And it appears worthy of notice, and tends to confirm the account given of the formation of our general ideas, at least those of visible objects, that the greater the variety subsisting among the individuals or subordinate species comprehended under the general idea, or, more properly, which possess that quality, or combination of qualities, which compose the general idea, the less attention, other things being equal, do we pay to the peculiarities of the individual. Thus the general notion of a triangle is merely that of a figure having three sides; and the varieties of triangles are innumerable: and, agreeably to the opinion already mentioned, though we certainly cannot form a conception of a triangle which shall be representative of all others, without possessing the peculiarities which constitute it an individual, yet the circumstances of its having three sides is so finite, and our attention is so thoroughly confined to it, that the peculiarities of the triangle are not unfrequently totally out of consideration; and if, ow-

ing to some particular associations, the triangle on such occasions were not usually the same, we should afterwards be unable to say what kind of a triangle had been in the view of our minds.

124. To state the fact respecting conceptions more generally; if we attempt to form a conception of any object, it must, from the very nature of a conception, be individual, representative, perhaps, of a numerous class, but still possessing those peculiar features which constitute individuality.—It may not be improper to suggest, that the want of attention to the difference between an idea and conception may have, in some measure, misled those philosophers who have denied the existence of general ideas. "The business of conception," says Mr. Stewart, "is to present us with an exact transcript of what we have felt or perceived;" and, admitting the truth of this, a conception is that transcript so presented.—We shall not enter into the inquiry, whether conception be a distinct faculty of the mind: we may, however, state, that it appears to us to be nothing different from memory, except as being a branch of that general faculty; and that a conception differs from an idea, only as species does from genus; that, in fact, without the aid of the associative faculty, and with retention alone, every idea would be merely a conception. For the recollection of an individual sensation, or group of sensations, whether seldom or frequently received, is a conception; but when a number of sensations possessing some common features, but in others differing, are received into the mind, the ideas they form there by the laws of association, coalesce with one another, thus constituting these complex ideas or states of mind, which never from their very nature can be conceptions, but which yet may be distinct, and when words are used to denote them, the subjects of reasoning.

125. To apply these remarks: Almost an infinite variety of the sensations we receive, are presented to our view so constantly connected with others, that however much it may be in the power of the mind to attend to them in a separate state, it is impossible to form a conception of them separately; but, on the other hand, there are a considerable number of qualities remote from mere sensation, belonging to an extensive range of individual objects, which may be considered by the mind separate from those objects, and have internal feelings or complex ideas attached to the terms which denote them. Now, we apprehend, it is the grand difference between our general notions, when concerned about things merely sensible, and those which we might call more purely intellectual, that in the former case, the conceptions being usually clear, and frequently very vivid, are very easily brought up by the associative power; and the circumstances of distinction being few, and merely sensible, are, from their very nature, calculated to produce a conception; and so little do we possess an abstractive power, that it is in most cases impossible to do this without introducing the conception of the whole object: on the other hand, the circumstances of distinction in the latter case, are less definite; they are frequently extremely numerous, and are seldom capable of exciting conceptions, and consequently they do not readily call up any particular individual object to which the general term is applicable.—We acknowledge, very much, in these latter respects, depends upon the peculiar circumstances of the case, or upon the habits of the individual. If a person had been remarkably struck with an act of justice, or of disinterested benevolence, or any other, it is probable, that while the vividness of the impression lasted, he would never be able to think of these qualities without the particular case being recalled into the mind; and if he possessed a lively imagination, or had been present at the performance of the virtuous action, would form an immediate conception of the whole scene. Or if a person be not much in habits of speculation, he would universally think of some example of the action possessing those qualities. But these circumstances, though they tend to illustrate the operation of the associative power, do not appear to militate against the general truth of the above remarks.

126. The remarks we have made on the subject of abstraction or generalization, have been, in a considerable degree, separate from language, or at least supposing it not already formed. If every person was left to form his own classifications, language, in very many instances, would be of little utility; because the same features of resemblance would not operate in the same way upon different individuals. But the process of the mind, when language is formed, is somewhat different; because in this case it is restrained, and has not the same unbounded liberty of forming its associa-

tions.—The mind of the child is not left to classify objects; but these objects are presented to it already classed, owing to the same word being used to express them; and it is very interesting to observe the efforts of the juvenile mind in finding out some features of resemblance between the objects which had previously been presented to him, and a new object presented to him with the same name.

IMAGINATION OR FANCY.

127. In the use which Mr. Stewart makes of the term imagination, it includes the fancy, and is in no respect a distinct power, as he himself states, but compounded of several others. "It includes," he says, "conception or simple apprehension, which enables us to form a notion of those former objects of perception or of knowledge, out of which we are to make a selection; abstraction, which separates the selected materials from the qualities and circumstances which are connected with them in nature; and judgment or taste, which selects the materials and directs their combination. To these powers we may add that peculiar habit of association to which I formerly gave the name of fancy; as it is this which presents to our choice all the different materials which are subservient to the efforts of imagination." "This," he observes in another place, "is the proper sense of the word, if imagination be the power which gives birth to the productions of the poet and the painter," and, we may add, of genius in general.—We have no objection to such an appropriation of the term; in the Hartleyan nomenclature, however, it is used indiscriminately in the sense in which the professor seems to employ the fancy.

128. The recurrence of ideas, says Hartley, especially visible and audible ones, in a vivid manner, but without any regard to the order observed in past facts, is ascribed to the power of imagination or fancy. Every succeeding thought is the result either of some new impression, or of an association with the preceding. It is impossible, indeed, to attend so minutely to the succession of our ideas, as to distinguish and remember for a sufficient time the very impression or association which gave rise to each thought or conception; but we can do this as far as it can be expected to be done, and in so great a variety of instances, that we have full right to infer it in all.—A reverie differs from imagination only in this, that the person being more attentive to his own thoughts, and less disturbed by external objects, more of his trains of ideas are deducible from association, and fewer from new impressions.—It is to be observed, however, that in all cases of imagination and reverie, the train and complexion of the thoughts depend, in part, upon the then state of body or mind. A pleasurable or painful state of the stomach, for instance, joy or grief, will make all the thoughts tend to the same cast. "Objects and circumstances may be so disposed," says Mr. Grant, (in a very valuable paper on Reverie, for which see "Manchester Memoirs," vol. i. or "Nicholson's Journal," vol. xv.) "as to give to reverie a pleasing or pensive, a refined or an elegant direction. I believe it is unnecessary to ask whether the mind will not be more apt to depart from serious meditation in a gaudy chapel, than in the solemn gloom of a cathedral? It is remarked by an eminent medical writer, that light, introduced by opening the window-shutters, gave a gayer cast to the ideas of a patient who laboured under reverie. The study of Tasso was a Gothic apartment, and he fancied his familiar spirit to converse with him through a window of stained glass."

129. We might very easily enlarge on this faculty, and particularly on the regulation of it, as affecting the character and the happiness; but we suppose that none of our readers, who are much interested in the pursuits of mental philosophy, are without access to Dugald Stewart's "Elements," in the last chapter of which they will find an elegant, scientific, and highly important consideration of this point; and as we have already gone to the limits of our article, we must hasten to a conclusion.—Our object has been to lay before or readers a view of the leading features of the most important of all sciences, next to religion, to which it is eminently subservient; and in accomplishing this object we have endeavoured to show its practical value. We have, in many places, made a most free use of Hartley's "Observations;" and we shall think ourselves happy if we shall have succeeded in making the way smoother for an acquaintance with that profound and invaluable work, among such of our readers as have not previously paid much attention to the subject. To such we beg leave to reccommend Mr. Belsham's "Ele-

ments," (of which we believe we have occasionally made use, without specific acknowledgment), Locke's "Essay," Dr. Priestley's "Abridgment" of Hartley, Allison's "Essays on Taste," and Professor Stewart's "Elements," as forming a pretty complete course of reading on Mental Philosophy.

130. As we have made a reference from Metaphysics to this article, our readers will probably expect from us something more metaphysical than what they will find in the foregoing part of it. We are not among those who consider metaphysics as that science, falsely so called, which professes to enlarge human knowledge beyond the limits of the objects of human contemplation, as the science of essences, &c.; but we must acknowledge that we are disposed to allow a high rank to a few only of those branches of metaphysics which do not justly class under the head of mental philosophy, or the philosophy of the human mind. We regard them as amusing speculations which may serve to sharpen the activity of the intellect, and which, confined within moderate limits, may be safely indulged in by those whose time and culture of intellect allow of such indulgence; but we are no advocates for the young philosopher spending his exertions upon them: they may, and we are aware often do, deeply interest the mind; but few who think much will be unwilling to allow that an active imagination, or simply the devotement of the mind to an object, will create any interest in that object which has no foundation in the real utility of it. We make these remarks with no wish to throw a stigma upon metaphysics in general, but simply to lead our readers to reject that stigma which many throw upon the philosophy of the human mind, but which belongs to some only of the branches of metaphysics; and of these, principally to those which the good sense of the present day regards merely as objects of curiosity, notwithstanding the efforts of the learned Harris to lead us back again into all the vagaries of the ancient philosophers. Whatever relates to the properties of the mind, to the operations of intellect and affection, is of high value in various points of view: as Dugald Stewart justly remarks, the philosophy of the mind, abstracted entirely from that eminence which belongs to it in consequence of its practical applications, may claim a distinguished rank among those preparatory disciplines, which Bishop Berkeley has happily compared to "the crops which are raised, not for the sake of the harvest, but to be ploughed in as a dressing to the land."

131. Physics, including in its widest extent natural history, is that grand division of human knowledge which has for its objects the properties, classifications, and laws, of all those things which affect the senses; metaphysics, *μετα τα φυσικα*, comprehends all those speculations which have for their aim the properties, classification, and laws, of all those objects of human thought which by sensation alone could not be known to man. The ancient metaphysics comprehended many objects which can scarcely be said to lie within the sphere of human knowledge, and which are rather to be considered as the reveries of imagination than as the realities of intellect; with these the science of metaphysics ought not to be confounded. We cannot pretend to give a complete enumeration of the objects of this science, but it will not probably be useless to give such a statement and brief consideration of them, as will at least more fully explain than is perhaps generally done, what kind of knowledge it professes to have in view.

132. In the first place, metaphysics comprehends all investigations respecting the existence and attributes of the Supreme Being. While we state this, however, we admit that we use the term in its widest extent. The most important, because the most undeniable, and generally convincing, of these investigations come under the head of natural theology, which derives its proofs of the existence and attributes of the Supreme Being from the appearances of nature. Revealed religion teaches us what God himself has been pleased to make known to us of his character: but this, though a just foundation of belief on this point, and the guide of sound philosophy, scarcely comes under the head of philosophy. Those religious investigations which most properly class under the head of metaphysics, tend to prove the Divine existence and attributes from certain principles which are supposed to be indisputable, by a series of reasoning altogether independent of the marks of design in the objects around us. Of these, we think that those which are to be found at the beginning of the second volume of "Hartley's Observations" are the most satisfactory. He sets out with this principle, 'something must have existed from all eternity,' which he thinks commands an instantaneous necessary assent, or at

least the contrary of which (*viz.* that there was a time when nothing existed) the mind of every one refuses to admit. He next proceeds to show, that 'there cannot have been a mere succession of finite dependent beings from all eternity; but there must exist at least one infinite independent being.' He concludes his reasoning in proof of this proposition, with a remark which we will quote, because many, feeling themselves embarrassed with what may justly be called the metaphysical proof of the existence of God, are apt to suppose, either that it has no weight, or that there is in their minds some wrong tendency, mental or moral, which impedes a ready assent to it. "Some of these (abstract metaphysical arguments) are more satisfactory to one person, some to another; but in all there is something of perplexity and doubt, concerning the exact propriety of expression, and method of reasoning, and perhaps ever will be; since the subject is infinite, and we finite." Indeed, we are decidedly of opinion, that any mind would justly be deemed an anomaly which, after resisting assent to the proof, *à posteriori*, fairly and attentively weighed and understood, should be led by the proof, *à priori*, to admit the existence of a first cause: and we strongly incline to the belief that the conviction which may be supposed to be derived from the latter, is in reality founded upon a previous, perhaps casual and even unintentional, consideration of the former.

133. This remark still more forcibly applies to the *à priori* arguments for the attributes of God. It is supposed to follow from the necessity of the existence of an infinite, independent being, that he necessarily is endued with infinite power and knowledge. We admit that it by no means follows, from what we think an indisputable position, *viz.* that no human intellect could have inferred the one from the other without the *à posteriori* proof, that therefore this inference has no force; but we do think that it is on the works of God alone that we can found a full and satisfactory proof of his power and knowledge; when these are admitted, however, we must resort to a metaphysical, but simple argument, to prove that they are unlimited.—We do not wish to lead our readers to the idea, that Hartley confines his reasonings to the *à priori* argument for the attributes of God; for this is by no means the fact; and we beg leave strongly to recommend to those of our readers who have not previously attended to them, those parts of his works which relate to the Supreme Being; we consider them as a treasure of profound reflections, which will serve as a clue to numberless difficulties, which may have perplexed and distressed the mind on the respective subjects.

134. Many proceed further in the metaphysical arguments respecting the attributes of God, and endeavour to prove, that the infinite, independent Being, possessed of infinite power and knowledge, must be infinitely benevolent. We acknowledge ourselves able to feel no other ultimate proof of this position than (what abundantly proves the benevolence of God, though perhaps not immediately the infinite benevolence) the happiness and tendencies to happiness which are observable in the sentient beings which fall under our notice. Admit the benevolence of God from his works, and then the infinity of that benevolence may be shewn by a simple metaphysical argument. "Since the qualities of benevolence and malevolence are as opposite to one another as light to darkness, they cannot co-exist in the same simple, unchangeable being. If, therefore, we can prove God to be benevolent, from the balance of happiness, malevolence must be entirely excluded; and we must suppose the evils which we see and feel to be owing to some other cause, however unable we may be to assign this cause, or to form any conceptions of it."—The divine benevolence, in every just view which the human mind can take of it, includes every moral quality which can exist in the divine mind; holiness, justice, mercy, truth, all, as attributes of God, are only modifications of benevolence: we need not therefore pursue these considerations further on this point.—Connected with the divine benevolence is one important class of speculations, *viz.* those which refer to the existence of evil. This is a subject which has for ages exercised the human understanding, and still it is regarded as the chief difficulty with which the theist has to contend. We will not attempt to weaken the reasonings of Hartley on this point, by laying an outline of them before our readers; but we confidently refer to his observations, as containing the most solid and satisfactory investigations respecting it, and what to all who fully admit his principles of mental philosophy must give views which shew the value of those

principles which, from their consistence with the dictates of religion, both derive confirmation and lustre.

135. Besides these objects of metaphysical speculation in connection with the Divine Being, there are some which seem to us to rank with the ancient metaphysics; such as, the mode of the divine omnipresence, the nature of the divine infinity, &c. Such things, it may reasonably be supposed, cannot be comprehended by finite beings; and if so, they cannot be the objects of human science, nor consequently of the pursuit of a wise man; but this no more argues against the science of metaphysics, than the absurdity of the pursuit of a perpetual motion against the science of mechanics, or of the search after the philosopher's stone against the study of chemistry.

136. Secondly, in the extensive sense of the term metaphysics, it comprehends all investigations respecting the operations, powers, and laws of the human mind, (which class under mental philosophy,) and respecting the grounds of obligation and of human duty, as far as they are derived from the consideration of the mental frame, (which class under moral philosophy.) It appears, however, that the term is more closely appropriate to those investigations which have for their object subjects connected with the study of the human mind, but which concern rather abstract speculation than practice; for instance, whether the human mind is a distinct, independent substance, or whether the human frame consists of one uniform substance and perception, with its modes, is the result, necessary or otherwise, of the organization of the brain; whether the human mind is necessarily incorruptible and immortal; whether there is an external world as the cause of our sensations; in what personal identity consists; whether power is an attribute of the human mind, &c.

137. Respecting the homogeneity of the human frame, we have already had an opportunity of saying a few words near the beginning of this article: it appears to us a purely metaphysical question, almost solely of importance in consequence of the frequent misrepresentations (real, though probably unintentional,) of the opinions of those who hold the affirmative side of the question, and of its supposed connection with the natural immortality of the soul. The fact is, that the modern materialists may be considered as having proved, what is admitted by some of the ablest natural philosophers, that solidity, and the absence of all active power, are not properties of matter; and while the principle of vitality is on all hands admitted as the result, necessary or otherwise, of a certain structure of matter, they see no greater difficulty in the hypothesis that the principle of percipiency is also. Perhaps, if the question had been taken up respecting the lowest of the animal tribes, all of which possess percipiency, and it had first of all been considered whether the phenomena of percipiency in them required the admission of a substance different from that by whose organization the phenomena of vitality in them is produced; and next, whether there is any essential difference between the percipiency of the lowest animals, and those which form the gradual ascending links between them and the highest of the brute creation; and, lastly, whether there is any essential difference between the phenomena of percipiency observable in them, and those in the uncultivated and almost brutal savage; if, above all, all ideas of connection between the immateriality of the human soul and its natural immortality had been relinquished, the question would have appeared less formidable, and admitted of an easier decision.

138. The affirmative of the next question, respecting the natural immortality of the soul, appears to us to be totally beyond the power of man to prove, from the light of philosophy at least. We have no idea of a substance separate from its properties; and even admitting that the human soul is a distinct substance from the body, what property is it known to possess which necessarily implies indestructibility? What proof is there that sensation, memory, intellect, or affection, must necessarily continue, when the substance with which they are at least united, ceases to exist in its organized state? We do not say that the contrary can be proved; but we are not metaphysicians enough to discover any arguments for the once common hypothesis, (now, we believe, usually relinquished by philosophical immaterialists), which have not been already found inadequate to prove the point. The question seems indeed of very little consequence, except to those who quit the guidance of revelation; all must depend on the will of the Supreme Being; and the indications of his will, to be derived from the moral arguments for a future life, and still more from the Christian revelation, are worth a host of reasonings to prove, that a substance of

which we can know nothing, excepting its property of percipiency, possesses what cannot follow from percipiency, because we have satisfactory ground to believe, that percipiency is at times totally suspended.

139. We shall have an opportunity of offering a few remarks on the next of the metaphysical inquiries which we have mentioned, in the article TOUCH, or FEELING, *sense of;* and we therefore proceed to the following subject, *viz.* respecting personal identity. This is a point of considerable importance, since, if the circumstances which constitute personal identity could be shown to be inconsistent with the infinitely important doctrine of a future life, it would greatly affect the evidences for that doctrine; but the fact appears to be, that all which true philosophy has to do, is to bring back the airy speculations of some metaphysicians to the level of common sense; to show either that they are unfounded, or that they have no immediate tendency to affect the belief in a future retribution. That we are through life, and under every change of body and of mind, the same intelligent accountable beings, is a fact which we know by consciousness; and whether we will or not, we must accept of this evidence. The only question is, what are the circumstances which constitute identity of person, amidst all the changes of body and of mind which a man undergoes in the course of a long life? If any and every hypothesis for the solution of this problem be insufficient, it does not follow that there is no such thing as personal identity; but merely that such hypothesis is unsatisfactory and untrue. The fact is, that different hypotheses have been advanced on the subject, that perhaps no one of them can be pronounced fully satisfactory, and that some metaphysicians, laying hold of the weak parts of such hypotheses, have actually professed to believe that there is no such thing as personal identity. The conviction, however, of permanent identity is happily too firmly inwrought in the mental system, to allow any thing but an attachment to system little short of insanity to eradicate it. Whether or not we can ascertain in what it consists, the consciousness of every individual is a constant and sufficient ground for his admitting the fact; and if any one should work up his mind to a speculative disbelief of it, while he continues to possess a prospective and retrospective capacity, sensation and mental feeling, he cannot, in any considerable degree, as far as this life is concerned, act upon his opinion. The chief importance of such an error respects its connection with a future state of retribution, and even here the incredulity of vice alone can, we should suppose, produce in a sane mind any doubt as to the continuance of identity. The grand point is, will the system of thought and affection to which the word *self* is applied, be raised again to activity; and if so, (and no contradiction can be urged against the strong evidence which we have for it), all is safe as far as respects the sameness of that self. And if to constitute personal identity it should be necessary that more than the same organization of matter be preserved as a vehicle for that system of thought and affection, that even the same system of particles should be preserved. Dr. Watts's hypothesis of permanent stamina, which, if not actually proved, has never been disproved, affords a proof of personal identity in this sense of word, which may satisfy the most scrupulous materialist, and the most captious sceptic. Respecting this subject, we refer our readers to the work from which we have derived several of the foregoing statements, *viz.* "Belsham's Elements of the Philosophy of the Human Mind;" where they will find a luminous view of this difficult subject, and references to the chief writers who have discussed it. They will also find in the same useful work, a view of several other of those discussions which we consider as most strictly metaphysical, with similar references.

140 The last of those questions which we spoke of in this department of metaphysics is, whether power is an attribute of the human mind. "Power, as an attribute of the mind," says Mr. Belsham, "may be defined, the capacity of carrying into effect the determinations of the will." Those philosophers who maintain, that it is an attribute of the human mind, argue from consciousness and observation; and they affirm, that though we cannot define it, we have a notion of it. Those who take the negative side of the question contend, that all we are conscious of is volition, and the effect produced; and that what some call a consciousness of power, is nothing more than a belief, that the effect will follow the volition, which belief is sometimes erroneous: they also argue, that our total ignorance of the manner in which muscular motion is produced, proves that the mind is not the efficient and proper cause of this wonderful effect.—We are of opi-

nion, that it is very much, though not wholly, a dispute about terms. Upon Mr. Belsham's definition of power, we should have supposed, that no difference of opinion could exist, whether it be a property of the mind; but they are very different questions, whether the mind possess such capacity in consequence of the ordinations of the Supreme Being, and whether, when exercising this capacity, it is to be considered as the efficient cause of muscular motions. In this sense, all causation appears to resolve itself into the constant agency of the Deity; and we see no reason to hesitate in admitting, that all the energies or powers both of body or of mind, are simply modes of his operation.

141. Some of our readers will probably be disposed to censure us, because we have not ranked the doctrine of necessity, as it is called, among the metaphysical speculations of this class. We are fully aware, that there is an abundance of abstruse discussion connected with it; but in its unencumbered, simple state, the doctrine of motives seems to rank among the practical laws of our frame. At any rate we shall not here enter upon the subject, having already given a short statement of the subject in its proper place: to which, therefore, we beg leave to refer our readers.

142. Thirdly, metaphysics claims as its own, all inquiries respecting the nature of infinity, motion, duration, space, &c. We do not mean to affirm, that these inquiries are destitute of value, certainly not that they are destitute of interest; but we cannot, as far as they are distinct from the practical laws of body or mind, attribute any very high importance to them. The speculations of the metaphysician respecting duration are among the most important of this class, and with the selection of some remarks on the subject from Belsham's Elements we shall close this article.—A succession of sensations and ideas is continually passing through the mind, during the state of vigilance, the knowledge of which we attain by consciousness. The idea of succession is acquired by reflecting upon this train of ideas and sensations, and from no other source. The velocity of the succession of ideas in the same person, is different at different times; and the variation is sometimes voluntary, and sometimes involuntary. The velocity of sensations must always correspond with that of the external impressions: that of ideas depends very much upon the state of the body: they seem to succeed each other with greater rapidity in the evening than in the morning, in youth than in age, in health than in sickness, in a cheerful frame of mind than when under depression. The course of ideas is in some degree obedient to voluntary efforts; but no effort can retain one in the mind beyond a very short time, nor can we call up any given number in a given time.

143. Duration, as applied to any finite being, signifies continued successive existence. The idea of duration is acquired from reflecting upon the succession of our ideas. While this succession continues, we are conscious of the continuance of existence; when it is suspended or forgotten, the consciousness of existence, and the idea of duration, is proportionably interrupted. Also, any portion of duration appears longer or shorter, in exact proportion to the number of ideas which are recollected in a given interval. While we ourselves continue to exist, we perceive that other beings, whether similar or dissimilar to ourselves, also continue to exist: hence we transfer the idea of duration, and even of successive duration, to them, and to all other beings that exist; and duration becomes a measure common to universal existence.—Duration is either limited, or unlimited. Limited duration is time; unlimited is eternity.—Duration, like space, can only be measured by itself; but it wants an advantage which extension possesses, and which arises from the possibility of applying one portion of it to another. The time that any one idea continues in the view of the mind is an instant; and during it we are insensible of duration, the very notion of which implies succession. The most natural measure of time, is the number of ideas recollected to have intervened between any two given instants; and when all other measures are wanting, this will answer tolerably well. Equable successions really existing, and regularly returning, serve as the most correct measures of time; such are the revolutions of the heavenly bodies, which being also various, and publicly visible, have been universally adopted, as the most convenient measures of time. These are, however, only the measures of duration, and not duration itself, which is the succession of ideas.

144. If the continued succession of ideas constitute the true duration of intelligent beings similar to ourselves, it will

follow: 1. That if thought be suspended between death and the resurrection, the two instants will appear to be contiguous, and with respect to every individual, will actually be so. 2. That the duration of the existence of an intelligent being is to be measured, not by the revolutions of the heavenly bodies, but by the number of ideas which pass through his mind in the course of his life. 3. That an Omnipotent Being, by increasing the velocity of the succession of ideas, may cause the same revolution of the heavenly bodies, which appears as a day to one, to appear as more than a thousand years to another. 4. That if a being, in all other respects constituted like ourselves, should have all his ideas at once present to his mind, without any succession, he could form no conception of successive duration. 5. That to an all-perfect mind, all whose ideas are equally, invariably, and at all times present, the attribute of successive duration can with no propriety be ascribed.

Philosophy, *moral.* 1. Since much of the happiness of this life, much of our ability to benefit others, since, in short, the happiness of a boundless existence, depends upon the proper regulation of our conduct and affections, surely it must be an object of the first importance, that we should learn the regulation to which they should be submitted. To know our duty and to practise it, are indeed two different things; but to practise our duty well certainly requires that we should know it well.

2. How shall we know it? Shall we consult the law of the land, or make the general conduct of mankind our guide? shall we bend our actions implicitly and constantly to the rules of holy writ, or follow invariably the dictates of our consciences? All these may be valuable, some are of inestimable value; but they do not supersede the necessity of moral investigation. The law of the land, as Paley justly observes, labours under two defects considered as a rule of life. First, human laws omit many duties, because they are not objects of compulsion, such as piety to God, bounty to the poor, forgiveness of injuries, education of children, gratitude to benefactors. The law never speaks but to command, nor commands but where it can compel; consequently those duties, which by their nature must be voluntary, are left out of the reach of the statute book, as lying beyond the reach of its operation and authority. Secondly, human laws permit, or, which is much the same thing, leave unpunished many crimes, because they cannot be settled by any previous description; such as luxury, prodigality, partiality contrary to the good of others, &c. For it must either settle the crime to be punished, or leave it to the magistrate to settle it; which is in effect leaving it to the magistrate to punish or not to punish at his pleasure.

3. The general conduct of mankind cannot be a safe guide. Scarcely is there a crime for which we may not find a justification in the general conduct of large societies; scarcely a disposition, however pernicious to individual happiness, which may not receive conformation from its allowed indulgence among whole nations. The bulk of mankind do not possess those advantages which enable those of cultivated minds to see almost at a glance the path of duty. What culture they have is often unskilfully applied; and therefore bad habits gain strength, and false notions of honour, pleasure, and interest, occupy their minds: they think less of what is right than of what will not expose them to punishment: and their consciences are seldom consulted, even where its decisions would be right.

4. To the rules of the scriptures we may indeed implicitly submit. He who steadily cultivates the dispositions which christianity enjoins, and conforms his conduct to its sacred precepts, cannot fail to mount high in the scale of moral worth. But this does not prevent the value of moral investigation. For in the first place it gives greater promptitude to our obedience, to perceive that those dictates are in perfect consistency with the laws of human nature; that an acquaintance with the laws of human nature, leads us to the conclusions forced upon us by the scriptures; that we should make the love of God, the love of our neighbour, and the law of our hearts, the guide of our actions, and of our affections.—But, secondly, the precepts of christianity are very general. This is absolutely necessary to render them of use as the guide of life. Were they voluminous as the laws of England, and the decisions of the supreme courts of justice, (which are said to fill at least fifty folio volumes,) they could not contain all the cases that would occur; for, as Paley observes, "it is not once in ten attempts that you find the case you look for in any law book whatever; to say nothing of those numerous points of conduct, concerning which the law professes not to prescribe or deter-

mine any thing." Were the rules of scripture equally particular, they would be useless from their extent; and they would be injurious too, because they would prevent the reference of our actions to the general principle, and we should be satisfied if our case were not stated in the christian system of morals. —Again, thirdly, it follows, from the christian precepts being so general, and principally regarding dispositions, that it not unfrequently requires some consideration to ascertain where they are directly applicable, and still more, whether they altogether coincide with one another in their direction. The virtuous dispositions may dwell together without opposition; a man may be generous, and grateful, and just: but the actions to which each prompts, may not have that consistency with one another, which would permit of their being brought into exercise; thus an external action which generosity and gratitude may solicit, justice may forbid. Hence it is of great importance to be able to form such a set of decisions, or, still better, such principles for decision as might present themselves when called for, and prevent us from giving to each class of virtuous actions a disproportionate attention; as should enable us to decide, when actions required it, to which class of virtue our preference should be given, where we ought to restrain the impulse of feeling, and where to allow it to be our unhesitating guide.—Besides, fourthly, as Paley justly remarks, the scriptures commonly pre-suppose in the persons to whom they speak a knowledge of the principles of natural justice; and are employed, not so much in teaching new rules of morality, as in enforcing the practice of it by new sanctions, and by a greater certainty, which last seems to be the proper business of a revelation from God, and what was most wanted.

5. But it may be thought there is a principle in the human mind which supersedes the necessity of moral investigation; which infallibly directs right even in the most minute circumstances. We know of no such principle. We know that there is a principle which springs up more or less in the mind of every human being, and which prompts to certain actions, and to avoid certain actions; but we cannot think, that the conscience is to be regarded in the light of a blind instinct: this would degrade the moral actions of man to a level with the instinctive actions of the brute; and it is unnecessary to resort to the supposition; its existence, its variations, its effects can be accounted for without it. See PHILOSOPHY, *mental.*

But in whatever light we regard the conscience, it is indisputable that its dictates are not uniformly the same in any mind, and that they are exceedingly variable, if not with respect to the grand principles of duty, with respect to the application of those principles in different individuals and classes of individuals. It is indisputable, that the moral principle grows to maturity from a small seed. It is indisputable that it is susceptible of culture; that if neglected, its judgments become wavering and impotent; that if its dictates be made to undergo revision, if corrected by the means of judgment which we possess, if its defects are supplied by those extended views of duty, its decisions become more firm, and in general more efficacious.

6. Even an ardent desire to keep with exactness the best rules of duty, will not render unnecessary attention to the cultivation of the conscience, and must therefore prompt to it. An instance occurs in point. Dr. Cogan, in his Treatise on the Passions, has the following remarks. "An instance of the influence of perverted principle occurs to my remembrance, in the conduct of a pious mother towards a most excellent and dutiful son, who, from a principle of conscience, in opposition to his interests, renounced the religious system in which he had been educated, for another which he deemed more consonant to truth. She told him, that she found it her duty, however severe the struggle, to alienate her affections from him, now he had rendered himself an enemy to God, by embracing such erroneous sentiments. My friend added, that she was completely successful in these pious endeavours; and that the duty which she enjoined upon herself was scrupulously performed during the remainder of her days." The same philosophic writer adduces another instance of the irregularity of the moral principle, in a young lady, in whose character mildness and compassion were pre-eminent features. "I was once passing through Moorfields," says the doctor, "with a young lady, aged about nine or ten years, born and educated in Portugal, but in the Protestant faith; and observing a large concourse of people assembled around a pile of faggots on fire, I expressed a curiosity to know the cause. She very composedly answered, I suppose it is nothing

more than that they are going to burn a Jew."

7. Need we proceed? is it not a truth indisputable as that we are living for a purpose beyond mere present gratification, "that moral excellence is the true worth and glory of man, and that, therefore, the knowledge of our duty is to every man, in every situation of life, the most important of all knowledge?"—Now moral philosophy is that science which teaches men their duty, and the reasons of it. We should be happy, if our limits allowed us, to enter minutely into this important subject; but we must content ourselves with laying before our readers such a view of those fundamental principles which are derived from the laws of our mental frame, as may furnish a guide and introduction to more extensive moral speculations, and may serve as a basis on which to found our "rule of life." In doing this, we shall make frequent and free use of the invaluable part of Hartley's observations which bear that title. We do not think it necessary to state where we have him: those who are acquainted, or who may be led, by what we here state, to an acquaintance with his rule of life, will easily perceive what we owe to him; and to others it would be useless. We also acknowledge our obligations to Mr. Belsham's "Elements of Moral Philosophy," which, (though we think in one or more of his statements, page 370, he has not enough attended to the power of the disinterested benevolent affections), we wish to recommend to the perusal of our readers. These, with Paley's "Moral Philosophy," in connection with Pearson's remarks and annotations on that work, will, we think, form a pretty complete course of reading on moral science, and will amply repay the attention given to them.

8. The chief questions in morals may be reduced to three. What is that quality of conduct, affections, or character, which render them obligatory upon a reasonable being constituted like man? What are those affections, conduct, and character, which possess this quality? What are the best means for the performance of that conduct, and the acquisition of those affections and that character?—The first of these we shall now proceed to consider.

Moral Obligation. The Criterion of Virtue.

9. The term obligation respects voluntary actions only. We say, we are obliged to walk if we wish to have health: we are obliged to regular exertion if we wish to acquire valuable mental habits; we are obliged to perform certain actions in order to attain certain ends.—The use of the term in this and similar situations, suggests its true import. Obligation expresses the necessary connection existing between a certain end and a certain means. Thus, if that end be the possession of health, the necessary means are, that we take exercise: if the end be the formation of valuable mental habits, a regular series of exertions is the necessary means; and, in short, in whatever case we wish to express that certain ends can only be obtained by certain means, we say we are obliged to use these means, in order to obtain these ends.

10. Obligation differs from compulsion. The former respects voluntary actions, the latter involuntary. Compulsion always implies some external force. Thus, a man is obliged in honour to pay his debts, and if he do not he will be compelled by the law; that is, if to satisfy the calls of honour be the end, the payment of his debts is the necessary means; if this obligation operate not sufficiently strongly as a motive, he will be compelled to do it against his will, by the law.

11. Obligation by no means implies an obliger. I may be obliged by reason, by interest, by convenience, by honour, by conscience, &c. as well as by the authority of another. Authority is one, but not the only source of obligation.

12. Moral obligation respects those actions which are denominated virtuous or vicious; we are obliged to perform the one, and to abstain from the other, because this is the necessary means, in order to effect a certain end, or certain ends. That is to say, unless we do practise virtue, and abstain from vice, we cannot obtain the end which wisdom points out as deserving pursuit.

13. As has been remarked of obligation in general, there may be various sources of moral obligation; that is, a person may be obliged to the performance of his duty by the laws of God, the dictates of his conscience, the hopes and fears of immortality. Whatever can be pointed out as the ultimate obligation, that is, that to which all others may be reduced, will also furnish the most general criterion of duty. Thus, if it appear that the ultimate obligation to virtue is the greatest happiness of the agent, then we should say, that virtue is that quality of an action, or affection, or character, by which it tends to the greatest happiness of the agent. In

other words, a certain character of action or disposition is a necessary mean to a certain end; that end may be various: suppose the ultimate end, or that to which all others are to be referred, is the greatest happiness of the agent, then it follows, that the tendency to the greatest happiness of the agent is that criterion by which we are to ascertain whether or not it is obligatory. To such a tendency we give the denomination of virtue.

14. Many sources of obligation have been pointed out by different philosophers. That is, to the question, Why ought I to act in a certain way which we call virtuously? many answers have been given. Some of the most important are the following.

15. It is agreeable, say some, to the eternal and necessary fitness of things.—This leaves the distinction between virtue and vice altogether arbitrary; for it depends upon the perception of a fitness or unfitness, which can only be ascertained by investigations, whose conclusions will differ in different individuals. Besides, it has justly been asked, What are those moral fitnesses fit for? If the fitness or unfitness of actions means any thing different from their tendency to produce happiness or misery, the expression is unintelligible. We may safely use the expression, for there is certainly a beauty and propriety in virtue, which increases in our estimation as virtue itself gains an influence in our breasts; but still, when we speak of it as an obligation, we find the question returning, Why ought I to act agreeably to the fitness of things?

16. It is agreeable, say others, to the dictates of right reason. Unless you can show me a reason, independently of your assertion, in what way am I bound to comply with what you call the rules of virtue? Besides, in what respect can an action be said to be agreeable to the dictates of right reason, but as it possesses some tendency to something? and what that something is, it leaves us to estimate for ourselves, and consequently does not bring us to the ultimate obligation which we are inquiring for.

17. It is the opinion of some, whose own confirmed habits of virtue probably were in some measure the cause of the opinion, that virtue carries in itself its own obligation; that the understanding represents a certain action, or set of actions, as right, and that therefore it ought to be performed.—It is objected, with great justice to this system, that it leaves the matter where it found it; for the question recurs, Why am I obliged to perform an action which my understanding represents to me as right? Further, it is arguing in a circle. My understanding represents such an action as right; that is, obligatory; and therefore I am obliged to perform it. Why does my understanding represent this action as right Besides, it refers to a kind of infallable judge within, whose dictates appear, in fact, to be very different in different persons. Felton believed that he did what was right, that, in short, he performed an action which was highly meritorious, when he murdered the duke of Buckingham. According to this, he was under an obligation to do it.—There cannot be a doubt that it is the part of true wisdom to endeavour to cultivate the moral powers, and then leave the actions entirely (except in extreme cases) to their suggestions. But to state, that an action is obligatory, because the understanding, or the conscience, (for it comes to the same thing) represents it as right, is to sanction as virtuous, some of the most depraved actions; some of the most depraved actions have been performed by those who thought it right to perform them.—The fact appears to be, that the advocates for this system, having spent much of their lives in cultivating their moral ideas, and finding them always correct, have acquired the habit of acting implicitly upon them, and hence have judged, that because they were represented by our conscience as right, therefore they were obligatory. This appears a sufficient obligation for those who have well-cultivated consciences; but it will answer in no other cases, and the question still recurs, Why is this action obligatory?

18. Because, say others, it is agreeable to the dictates of the conscience.—The observations under the last head have anticipated what might be made here. When we analyze the grounds of the moral feelings and sentiments, (See Philosophy, *mental*), we shall see, that they cannot be safely made the infallible rule of our conduct, still less can they furnish the ground of obligation.—It cannot, however, be too strongly impressed upon the mind, that correct dictates, and the exaction of implicit obedience to those dictates, constitute the perfection of the conscience.

19. But when we say it is agreeable to the will of God, we seem incapable of advancing further. We surely are obliged

to perform the will of God by every consideration.—Most true, and yet we are not come to the last obligation. Even in the sentence we have just used, we have, without intending it, referred to some other.—Under the dominion of a wise and good God, there cannot be a doubt, that obedience to his commands is the highest wisdom; but why? It is a question that admits of an answer, and may therefore be put, though reverently: Why am I obliged to do the will of God? And the answer is obvious. Obedience to the commands of a benevolent God must be productive of the greatest ultimate happiness.—Not that it is necessary frequently to take this into consideration; for when we have ascertained that we are walking surely, we may walk safely without that degree of attention which, before such asscertainment, might have been necessary. To obey the will of God in all things is the highest point of wisdom; and he is most obedient who obeys because he loves.

20. Every question, Why is any one obliged to perform a certain action? gives us an ultimate answer; because it tends to the greatest ultimate happiness of the agent. When we arrive at this point, it is obvious we can go no further.—And, though true wisdom undoubtedly directs, that in order to attain the highest point of moral excellence, we must leave our own happiness out of consideration, yet there cannot be a doubt, that there could be no obligation to any conduct in opposition to happiness on the whole.—If self must be annihilated, it is because self-annihilation, or self-oblivion, is necessary for the attainment of the highest possible happiness.—Here, then, we come to the ultimate obligation, and upon this ground we shall build our moral superstructure. Though the principle appears a selfish one, it will be found, that the deductions from it are completely the reverse.—It has been remarked in favour of this as the ultimate obligation, that no nearer obligation could ever be admitted, which cannot at last be resolved into this ultimate one: that happiness is the end of the whole creation, though the means by which it is to be obtained are not always in themselves happiness; and that revelation itself assumes this as the ultimate reason of all its requisitions.

21. We now proceed to the second enquiry (§. 8.) What are those affections, conduct, and character, which tend to the greatest ultimate happiness of the agent; and in considering this the third will receive an answer. We shall chiefly confine our inquiries to the affections, for the reason already stated, (§. 7.) and we shall make an estimate of the value of the different pleasures and pains of the mind. This will lead to what we deem an indisputable conclusion, from the laws of the mental frame, that the love of man, of God, and of duty, (in other words, the affections of benevolence and of piety, and the moral sense,) should be the primary objects of our aim; and this because he will be most happy, in whom those affections exist in the greatest strength and vigour. We have already stated (Philosophy, *mental*, §. 73—99.) the Hartleyan classification of feelings; and we shall here presuppose that our readers are acquainted with it.

I. ESTIMATE OF SENSIBLE PLEASURES.

22. The first pleasures and pains of the human being are obviously those of sensation, and they form one source of enjoyment, and still more of suffering, during the whole of life. It is from these that the whole round of mental or intellectual pleasures and pains is composed.—To estimate the value of these pleasures, in their uncompounded state, take the extreme case, that any one pursued them as a primary object, laying aside all restraint from the virtues of temperance and chastity, he would soon destroy his bodily faculties, thus rendering the objects of sensible pleasure useless; and he would precipitate himself into pain, diseases, and death, evils of the first magnitude in the eyes of the voluptuous. "This is a plain matter of observation, verified every day by the sad example of loathsome, tortured wretches, that occur which way soever we turn our eyes, in the streets, in private families, in hospitals, in palaces." Positive misery, and the loss even of sensible pleasure, are too inseparably connected with intemperance and lewdness, to leave room for doubt even to the most sceptical.—The sensual appetites must therefore be regulated by, and made subservient to, some other part of our natures, else we shall miss even the sensible pleasure which we might have enjoyed, and shall fall into the opposite pains, which are in general far greater and more exquisite than the sensible pleasures.

23. The same conclusion also follows

from the fact, that inordinate indulgence in sensual gratifications destroys the mental faculties, exposes to external inconveniencies and pains, is totally inconsistent with the duties and pleasures of benevolence and piety, and is all along attended with the secret reproaches of the moral sense, and the horrors of a guilty mind. Such is the constitution of our mental frame, that the formation of mental feelings and affections cannot be altogether prevented; but that an inordinate pursuit of sensible pleasures converts the mental affections into a source of pain, and impairs and cuts off the intellectual pleasures.

24. The same thing may be concluded from the fact, that the sensible pleasures are formed first, and the mental pleasures from them, by the associative power. Now it is a general principle in the order of nature, that the prior state or means is less perfect and important than the posterior state or the means. Hence the sensible pleasures cannot be of equal value and dignity with the mental, to the generation of which they are made subservient.—This inference may be drawn from the analogy of nature, without reference to the infinite benevolence of the Supreme Being, which, however, makes it more satisfactory.

25. Further, the mental pleasures are more consistent with the gentle, gradual decay of the body, than the sensible pleasures, because, as they are formed from the combination and coalescence of many sensible pleasures, they more affect the sensible system at large; while the sensible pleasures principally affect the particular parts of the system to which they belong, and therefore, when indulged to excess, they injure or destroy their respective organs before the whole body comes to a period.

26. Lastly, the duration of mere sensible pleasure is necessarily very short, and cannot, even when free from guilt, afford any pleasing recollections; whereas one of the principal tendencies of our nature is, and must be, the pleasures of reflection and consciousness. In like manner, the evident use and restriction of one of the chief sensible pleasures to preserve life and health, with all the consequent mental faculties and executive bodily powers; of the other to continue the species, and to generate and enlarge benevolence, makes the subordinate nature of both manifest in an obvious way.

REGULATION OF THE PURSUIT OF SENSIBLE PLEASURES.

27. The foregoing remarks prove, that the pleasures of sensation ought not to be made the primary pursuit of life, but require to be regulated and restrained by some foreign regulating power. That they should be submitted to the precepts of benevolence, piety, and the moral sense, may be proved, by shewing that by this means they will contribute both to their own improvement, and to that of other parts of our natures.—Now benevolence requires, that the pleasures of sense should be made entirely subservient to health of body and of mind, so that each person may best fill his place in life; best perform the several relative duties of it; and, as far as in him lies, prolong his days to their utmost period free from great diseases and infirmities. All gratifications, therefore, which tend to produce diseases of body, or irregularities of mind, are forbidden by benevolence, and the most wholesome diet as to quantity and quality enjoined by it. It also most strictly forbids all gratifications by which the health or virtue of other individuals is injured, or by which encouragement is given to others to depart from the rules of chastity and temperance.—The precepts of piety are to the same purpose, whether they are deduced from our relation to God, as our common father and benefactor, who wills that all his children should use his blessings so as to promote the common good; or from the natural manifestations of his will, in the immediate pleasures and advantages arising from moderate refreshment, and the manifest inconveniencies and injuries caused by excess in quantity or quality; or from his revealed will, by which temperance in all sensible pleasures is commanded, and intemperance severely threatened.—In like manner the moral sense directs implicitly to the same moderation, whether it be derived explicitly from the foregoing rules of benevolence and piety, or from ideas of decency, rational self-interest, the practice of wise and good men, the disgusting nature of the diseases consequent on intemperance, the odiousness and mischief of violent passions, &c. It is evident, therefore, that all these guides of life lead to the same end, *viz.* great moderation in sensible enjoyments, though they differ somewhat in their motives, and in the commodiousness of their application, as a rule in the particular occurrences of life.

28. By this steady adherence to moderation, we are no losers even with repect to sensible pleasures themselves; for by these means our senses and bodily powers are preserved in their best state, and as long as is consistent with the necessary decay of the body; and this moderation, and its beneficial consequences, directly tend to inspire the mind with perpetual serenity, cheerfulness, and good-will, and with gratitude to the giver of all good.—In the common intercourse of life, associated circumstances add greatly to the pleasures of sensation: thus the pleasure of receiving a thing from a friend, or sharing it with a friend, sociality and mirth at the time of enjoyment, &c. greatly enhance the gratification of taste. Much more then will the pure and exalted pleasures of piety and benevolence increase these pleasures.

29. We are, then, great gainers on the whole by religious moderation as to sensible pleasures; still more so as to the sensible pains and sufferings which the intemperate bring on themselves. These are of the most exquisite kind, and often of long duration, especially when they give intervals of respite. They impair the bodily and mental powers, so as to render most other enjoyments insipid and imperfect; they dispose to peevishness, passion, and murmuring against Providence, and are attended with the pangs of a guilty mind.—On the whole, the proper method of avoiding the sensible pains, whether the result of excess, or such as occur in the daily discharge of the duties of life, and of obtaining the sensible pleasures in their best and most lasting state, is not to aim at either directly, but in every thing to be guided by the dictates of benevolence, piety, and the moral sense. It is evident that luxury, self-indulgence, and an indolent aversion to perform the duties of a man's station, not only bring on gross bodily diseases, but previously to this, often produce such a degree of anxiety and fearfulness in minute affairs, as to make persons inflict upon themselves greater torments than the most cruel tyrants could inflict.—There are cases, however, in which persons are obliged, from a sense of duty, from benevolence, from adherence to true religion, &c. to forego pleasure, and to endure pain; and this, where there is no probability of a recompense in this life. Here the hopes of futurity lend their aid; and the present pleasure which these afford, is in some cases so great, as to overpower, and almost to annihilate the opposite pains.

Rules respecting Sensible Pleasures.

30. "The only rule with respect to our diet," says Dr. Priestley, in his Institutes, "is to prefer those kinds, and that quantity, of food, which most conduce to the health and vigour of our bodies. Whatever in eating or drinking is inconsistent with, and obstructs this end, is wrong, and should carefully be avoided; and every man's own experience, assisted with a little information from others, will be sufficient to inform him what is nearly the best for himself in both these respects; so that no person is likely to injure himself through mere mistake."

31. It is sufficiently obvious, that it is the benevolent affections which give the chief value and highest interest to the sensible pleasures arising from the intercourse of the sexes; and it also appears that these pleasures were designed by the great Author of our frame, to be one chief means of transferring our affection and concern from ourselves to others. If, therefore, this great source of benevolence be corrupted or perverted, the social affections depending on it will also be perverted, and degenerate into selfishness or malevolence. These considerations of themselves point to marriage as the only justifiable mode of indulging the sexual passion.—Unrestrained promiscuous intercourse would produce the greatest evils, public and private: by being unrestrained, it would destroy the health, and prevent the propagation of the species; by being promiscuous, it would be ineffectual to promote the tender and benevolent charities, either between the individuals themselves, or towards their offspring, and would produce endless contentions among mankind. Now, though scarcely any known nation has allowed of such entire licentiousness, yet the evils arising from any great degree of it are so abundantly obvious and important, that they have almost universally led to some such regulation of sexual intercourse as that of marriage, and prove its necessity for the well-being of society.—Further, (to use the words of Paley, whose excellent remarks on this subject we shall freely employ, as suits our purpose), the public use of marriage institutions, also, consists in their promoting the production of the greatest number of healthy children, their better education, and the making of due provision for their settlement in life; and, in their promoting the private comfort of individuals, and particularly of the female sex. It may be

true, all are not interested in this last reason: nevertheless, it is a reason to all for abstaining from any conduct which tends, in its general consequence, to obstruct marriage; for whatever promotes the happiness of the majority, is binding upon the whole.—These considerations prove that the restraint of marriage-institutions is an essentially important obligation. It may be violated by vagrant concubinage, or by cohabitation limited to a single individual. The former will be the object of the next paragraph: the latter cannot be placed upon the same footing with it, in several respects; but as it can answer the primary public ends of marriage in only a few cases, as it tends to annihilate the individual advantages which are naturally derived from it (both as to moral welfare and to comfort), and as it decidedly discountenances marriage, and consequently, in the present state of society, countenances fornication, it follows that it is immoral. "Laying aside the injunctions of the Scriptures," says Paley, "the plain account of the question seems to be this: it is immoral, because it is pernicious, that men and women should cohabit, without undertaking certain irrevocable obligations, and mutually conferring certain civil rights; if, therefore, the law has annexed these rights and obligations to certain forms, so that they cannot be secured or undertaken by any other means, which is the case here (for whatever the parties may promise to each other, nothing but the marriage ceremony can make their pormise irrevocable), it becomes in the same degree immoral, that men and women should cohabit without the interposition of these forms."

32. With respect to the crime of fornication, it is to be observed. that promiscuous concubinage tends greatly to discourage marriage, and therefore to defeat the several beneficial purposes spoken of in the last paragraph. The reader will learn to comprehend the magnitude of this mischief, by attending to the importance and variety of the uses to which marriage is subservient; and by recollecting that the malignity and moral quality of each crime is not to be estimated by the particular effect of one offence, or of one person's offending, but by the general tendency and consequence of crimes of the same nature. If one instance of licentious indulgence be innocent or allowable, why should not more? and if allowable in one, why should not licentiousness become general? and if it were so, what dreadful consequences would follow? Every instance of licentious conduct has the direct and decided effect of leading to these dreadful consequences (which none but a purely malevolent being could contemplate without horror); and every instance is therefore criminal, altogether independent of its individual effects and tendencies. Again, fornication supposes prostitution, and prostitution brings and leaves the victims of it to almost certain misery. It is no small quantity of misery in the aggregate, which, between want, disease, and insult, is suffered by those outcasts of human society who infest populous cities: the whole of which is a general consequence of fornication, and to the increase and continuance of which every act and instance of fornication contributes. Further, fornication produces habits of ungovernable lewdness, which introduce the more aggravated crimes of seduction, adultery, violation, &c. Of this passion it has been truly said, that irregularity has no limits; that one excess draws on to another; that the most easy, therefore, as well as the most excellent way of being virtuous, is to be so entirely. However it be accounted for, the criminal intercourse of the sexes corrupts and depraves the mind and moral character more than any single species of vice whatsoever. That ready perception of guilt, that prompt and decisive resolution against it, which constitutes a virtuous character, is seldom found in persons addicted to these indulgences. They prepare an easy admission for every sin that seeks it; are, in low life, usually the first stage in men's progress to the most desperate wickedness; and, in high life, to that lamented dissoluteness of principle which manifests itself in a profligacy of public conduct, and a contempt of the obligations of religion and moral probity. Add to this, that habits of libertinism incapacitate and indispose the mind for all intellectual, moral, and religious pleasures; which is a great loss to any man's happiness. Lastly, fornication perpetuates a disease, which may be accounted one of the sorest maladies of human nature; and the effects of which are said to visit the constitution of even distant generations. The passion being natural, proves that it was intended to be gratified; but under what restrictions, or whether without any, must be collected from other considerations.—If fornication be criminal, all those incentives which lead to it are accessaries to the crime, and as such are criminal (inde-

pendently of their injurious effects upon the mind, which however are very great); for instance, lascivious conversation, whether expressed in obscene, or disguised under modest, phrases; also, wanton songs, pictures, and books; the writing, publishing, and circulating of which, whether out of frolic, or for some pitiful profit, is productive of so extensive a mischief, from so mean a temptation, that few crimes within the reach of private wickedness, have more to answer for, or less to plead in their own excuse.

33. Though the sexual desires are very strong, yet there is abundant reason to believe that they are not originally much disproportionate to their end; and that if due care were taken, they would not arise in youth much before the proper time for this end. But the violence and unseasonableness of these passions are so manifest in the generality of young persons, that one cannot but conclude the general education of youth to be grossly erroneous and perverted: and this will appear very evident, in fact, upon examination. The diet of children and young persons is not sufficiently plain and sparing; a proper regulation of which would lay a better foundation for health, and freedom from diseases, and put some check upon these passions. They are brought up in effeminacy, and neglect of bodily exertion, which would materially assist to prepare both body and mind for the discipline of life, and would restrain the sexual passion. The due culture of the mind, especially in respect of religion, is very generally neglected; so that the young are usually left without employment for their thoughts, and destitute of the chief armour, that of religious motives, whereby to oppose temptation.—Lastly, the conversation which they hear, and the books which they are allowed to read, are so corrupt, in this respect, that it is a matter of astonishment how a parent, who has any serious concern for his child, can avoid seeing the immediate destructive consequences, or think that any considerations relating to this world can be a balance to them.

II. ESTIMATE OF THE PLEASURES OF IMAGINATION.

(PHILOSOPHY, *mental*, § 73, 74.)

34. It does not appear from actual experience, that those who devote themselves to the study of the polite arts, or of science, or to any other pleasure of mere imagination, as their chief end and aim, do attain any greater degree of happiness than the rest of the world. The frequent repetition of these pleasures cloys, as in other cases; and though the whole circle is extensive, yet no one can grasp the whole, and as a matter of fact few apply themselves to more than one or two considerable branches. From the manner in which the feelings of imagination are usually generated and transferred upon their several objects, it might be expected that deformity would often be mixed with beauty, so as to produce an unpleasing discordancy of opinion, even in the same individual: and, as a matter of fact, it is not uncommon for men, after a long and immoderate pursuit of one class of beauty, natural or artificial, to deviate into such by-paths and singularities, that the objects excite rather pain than pleasure; their limits for excellence being narrow, and their rules absurd, and all that falls short of these being condemned by them as deformed and monstrous. Eminent votaries of this kind are generally remarkable for ignorance and imprudence in the common affairs of life, thus subjecting themselves to ridicule and contempt, and to real, great, and lasting inconveniencies. Vanity, moroseness, and envy, are too generally the concomitants of an overweening attention to the pursuit of these pleasures. And scepticism in religious matters is too frequent an attendant here, which, if it could be supposed free from danger as to futurity, is at least very uncomfortable as to the present. The almost necessary consequence of such confined attention is, that too high a degree of importance is given to the object, and the superiority which is supposed to be possessed in it, is supposed also to extend to other cases in which the individual is perhaps uncommonly ignorant; and thus he either becomes dogmatical or sceptical; qualities which, though apparently different from each other, are, in reality, to be considered as antecedent and consequent, dogmatism being frequently followed by scepticism. And as religious knowledge, to be properly cultivated, requires that the soil should be prepared by the benevolent and pious affections, and no kind of learning being of itself sufficient to give this preparation, if attention to the pursuit of literature or of science be so inordinate as to suppress the growth of these affections, religion itself will be treated as incomprehensible, absurd, uncertain, or incredible However, it is difficult to represent, justly, what is

the genuine consequence of the pursuit of the mere pleasures of imagination, their votaries being also generally actuated by motives of ambition; but, as will be seen hereafter, this does not invalidate any of the foregoing remarks. It is justly observed by Dr. Percival, that the endless progression of knowledge is apt to give the love of it an inordinate ascendancy over every other principle; and as this passion does not, like the love of virtue, temper its particular exertions, by preserving a due subordination of the powers which it calls into action, the wildest extravagancies of emotion and of conduct, have been displayed by those who have submitted to its uncontrouled dominion.

35. Further, we have reason to suppose that the pleasures of imagination ought not to be made our chief end and aim, because, in general, they are the first of the intellectual pleasures, come to their height early in life, and decline in old age. There are some few indeed who continue devoted to them through life; so there are some to the pleasures of sensation; but both are irregularities, which cannot be considered as indications of the designs of Providence respecting these pleasures. Hence the argument, (§ 24.) is applicable to these pleasures also. Like every other part of the great machine, they have their use, but it is a subordinate one; they tend to the improvement and perfection of our nature, but eminence in them is not that perfection. They teach a love of regularity, exactness, truth, simplicity: they lead to a knowledge of many important truths respecting themselves, the world in general, and its author; they habituate to invent and to reason; and when the social, moral, and religious affections begin to be generated in us, we may make a much quicker progress towards the perfection of our natures, by having a due stock, and no more than a due stock, of knowledge in natural and artificial things, of a relish for natural and artificial beauty.

Regulation of the Pleasures of Imagination.

36. As the pleasures of imagination are manifestly intended to generate and augment the higher orders of benevolence, piety, and the moral sense, so these last may be made to improve and perfect the former.—Those parts of the arts and sciences which inspire us with devout affections, and enable us to be most useful to others, abound with the most and greatest beauties. Thus, the study of the scriptures, of natural history, and natural philosophy, of the frame of the human mind, &c. when undertaken with pious and benevolent intentions, lead to more interesting and surprising truths, than any study intended for mere private amusement.

37. Further, since the world is a system of benevolence, and consequently the author of it is the object of unbounded love and adoration, benevolence and piety are the only true guides in our inquiries into it, the only clues which will lead through the labyrinths of nature. In the pursuit of every branch of valuable knowledge, let the inquirer take for granted, that every thing is right on the whole, that is, let him with a pious confidence seek for benevolent purposes, and he will find the right road, and, by a due continuance in it, attain to some new and valuable truth; whereas every other principle and motive for examination, being foreign to the great plan upon which the universe is constructed, must lead to endless mazes, errors, and perplexities.—Again, it is to their tendency to the increase of happiness that almost all truths owe their lustre. Hence those whose minds are under the influence of benevolence, will have the highest gratification which the perception of those truths can produce.

38. Lastly, the pleasures of the imagination point to devotion in a particular manner, from their unlimited nature. All the feelings derived from beauty, both natural and artificial, begin to fade and languish after a short acquaintance with it; novelty is a never failing requisite; we look down with indifference upon what we comprehend easily, and feel the wish to aim at such things as are but just within the compass of our present faculties. To what inference does this tendency to press forwards, this endless grasping after infinity, necessarily lead us? Is it not that the infinite Author of all things has so formed our faculties, that nothing less than himself can be an adequate object for them: that nothing finite, however great and glorious, can afford full and lasting satisfaction: that as nothing can give us more than a transitory delight, if its relation with God is excluded, so every thing, when considered as the production of his infinite wisdom and goodness, will gratify our utmost expectations, since in this view we may rest satisfied that every thing has numerous uses and excellencies, and that in the course of nature, the least and vilest, according to common apprehension, bear a proper part, as well as

those whose superiority over them is very great.—In fine, then and then only is science a worthy object of pursuit, as a primary object, when it is pursued with just views; when it is valued for its tendency to form valuable mental habits, and to cultivate moral ones; when we appreciate its value by its enlarging our capacity of usefulness to our fellow-men, and by its enabling us to raise our minds from sense to intellect; when we make it the path to religious and moral worth. As a means, it is highly conducive to the purification and perfection of our nature; pursued as an end, it will engross the affections, and the more noble and fascinating, than the sordid or sensible pleasures, will by degrees become a more dangerous and obstinate evil than those.

III. ESTIMATE OF THE PLEASURES OF AMBITION.

(PHILOSOPHY, *mental*, § 75—78.)

39. That the pleasures of honour ought not to be made a primary object of pursuit, appears from the following considerations. An eager desire of the pleasures of honour, and an earnest endeavour to obtain them, has a manifest tendency to disappoint itself. The merit of actions, that is, that property for which they are extolled, and the agent loved or esteemed, is that they proceed from benevolence, or some other moral or religious consideration: whereas, if the desire of praise form any considerable part of the motive, we censure rather than commend. But if praise be supposed the greatest good, the desire of it will prevail over other desires, and vanity, self-conceit, and pride, qualities which all regard as contemptible, will be the necessary consequents.—Again, if praise be considered as the supreme good of the species, what is there which shall be selected as the greatest subject of encomium. What is there which shall be the universal object of praise, as well as within the reach of every one. External advantages, riches, beauty, strength, &c. These are neither in the power of all, nor universally commended. Great talents, wit, sagacity, invention; these, though more the subjects of encomium, fall to the lot of very few only. In short, virtue alone is both universally esteemed, and in the power of all who are sufficiently desirous to attain it. But virtue cannot consist with the pursuit of praise, much less with its being made a primary object. Hence it ought not to be made such.—Even those who possess the advantages which are made the subject of praise, can seldom pursue praise with success. Praise cannot be the lot of many, because it supposes something extraordinary in the thing praised; so that he who pursues it must either have a very good opinion of himself, which is a dangerous quality in the seeker of praise, or allow that there are many chances against him.—The same conclusion is drawn, if we consider the progress of the pleasures of honour. Children are pleased with encomiums upon any advantageous circumstances which relate to them, but this wears off by degrees; and as we advance in life, we learn more and more to confine our pleasures of this kind to things within our own power, and to virtue. In like manner, the judicious part of mankind, that is, those whose praise is most valued, give it only to virtue, and those feelings and habits of which virtue is the basis. Here again is a manifest subserviency of these pleasures to virtue: they not only tell us, that they are not our ultimate end, but show us what is.

40. There is something extremely absurd and ridiculous in supposing a person to be perpetually feasting his mind with the praises that already are, or which he hopes will be hereafter given to him. And yet, unless a man does this, which besides would incapacitate him for deserving or obtaining praise, how can he fill up a thousandth part of his time with the pleasures of ambition.—Further, men who are much commended are apt to think themselves above the level of the rest of the world, and it is evident, that praise from inferiors wants much of the high relish those expect who make praise an object: it is even uneasy and painful to a man to hear himself commended, though he may think it his due, by a person whom he does not think qualified to judge. And in this view of things, a mind which has acquired truly philosophical and religious notions, sees immediately that all the praises of mankind are comparatively of no value, because no man can be a thoroughly competent judge of the actions and motives of others.—Lastly, the desire of praise carries us from less to greater circles of applauders, at greater distances of time and place; hence it necessarily inspires us with an eager hope of a future life. Now, all reflections upon a future life, the new scenes which will be unfolded there, the discoveries which will then be made of the secrets of all hearts, must cast a damp upon every ambition, except a virtuous

one, and produce diffidence even in those who have the best testimony of their conscience.

Regulation of the Pleasures of Honour.

41. We have already seen sufficient ground for the position, that it is a law of our natures, that the inferior sources of happiness are most productive of happiness when not made the primary objects of pursuit, but submit to the direction of the higher means. This is eminently the case with respect to the pleasures of honour. They may undoubtedly be obtained in their highest degree, and in their greatest perfection, by paying a strict regard to the precepts of benevolence, piety, and the moral senses. These precepts lead to the attainment of those qualities, and the performance of those actions, whose value is universally felt, and universally admitted; and at the same time preserve from that ostentatious display of them, or of other supposed grounds of honour, which would render their possessor ridiculous or contemptible. Honour is certainly affixed by the bulk of mankind to actions of benevolence, such as acts of generosity, compassion, public spirit, &c., and the encomiums bestowed upon such actions are one principal source of the feelings of the moral sense. The maximum of honour, therefore, must coincide with benevolence and the moral sense, and consequently with piety also, which is closely connected with them. It must, however, be admitted, that direct acts of piety are by no means calculated to gain the honour of the world in general, but, on the contrary, they expose to the reproach of enthusiasm, superstition, &c.; on the other hand, however, it must also be admitted, that humility, which is the principal of all the qualifications which recommend men to the world, cannot be obtained in any high degree without piety. Hence piety directly leads to the honour of men, and at the same time, in proportion as piety increases in its efficacy on the mind, the fear of this censure gradually diminishes.

42. The grand source of honour, directly or indirectly, is the tendency of an action or disposition to happiness of some kind or other, occurring to a man's self, or to the world, by his means. He, therefore, who is most happy in himself, and contributes most to the happiness of others, must in the end, from the very law of our natures, have the greatest quantity of honourable associations conferred upon him. But it has already appeared, in part, that benevolence, piety, and the moral sense, are the only true lasting sources of private happiness; and that the greatest public happiness arises from them cannot be doubted by any one; hence he in whom these qualities are prevalent, will, as far as his character is known and understood, obtain the applause of all, both good and bad. The esteem of the good he will first obtain, because they can most easily estimate his worth; and it is this alone which is valuable and useful in exciting to honourable attainments.

43. In proportion as the views extend, and the comprehension of the mind increases, the desire of honour, esteem, and approbation, will require higher sources of gratification than that of men, even of the wise and good: it rises even to the throne of the Most High, and from him to whom all hearts are open humbly hopes for approbation. This greatest of all honours can undeniably be obtained only by a regard to piety, benevolence, and the moral sense. If the desire of it be not the desire of our minds, it must arise from such inattention to the most important relations in which we stand, as is totally inconsistent with our true happiness; and if it become a ruling principle of our minds, all encomiums will derive their value from their consistency with the highest standard of honour.

On the Effects of Pride and Vanity.

44. Before we offer any remarks on this point, it may be requisite that we explain in what manner we use our terms, since they are employed with great latitude, so as to throw discredit upon ethical representations respecting pride and vanity: and since by the transference of the association connected with what is called laudable pride, to a quality of the mind which in every shape of it is a vice, that abhorrence of it is diminished, which its obvious ill consequences should always produce. By pride, we understand an unjust feeling of superiority over others, or of elevation in the scale by which the individual estimates honour; by vanity, an excessive desire of the praise or good opinion of others. The former indicates an unfounded opinion as to the title to honour: the latter is generally accompanied with some opinion of

that kind, but does not necessarily imply more than an eager desire of it.

45. Pride and vanity may exist almost singly in the mind: there may be those to whom their own good opinion, independently of the approbation of God, shall be every thing; and who find the sympathy of others totally unnecessary for the nurture of their own pride. In the present state of society this is not common; the good opinion of others is productive of too many important consequences ever to permit pride to be thus fostered, except where it is the effort of a strong, but ill-directed mind, to counterbalance the disappointments of vanity. He who has made the good opinion of others the primary object of pursuit, having met with its sure consequence, disappointment in his wishes, if he have not lost all his strength of mind by the weakening effects of vanity, will endeavour to rise above it; and if he have no religious principles, or but little religious culture, will dwell with gratification upon all the fancied excellencies of his own character, till they have acquired in his mind an importance to which they are little entitled: then moroseness must be the predominant feature in his temper, for he cannot bear that others should treat him with less respect than he thinks he has a right to claim; till at last an almost total unconcern for the opinion of others is forced upon his mind, and having no higher principle of action, he becomes a misanthrope. It is probably doing no injustice to the character of Swift, when we mention him as having gone this round.—But this is an extreme case: pride leads a man to set too high a value upon himself; but it is only that strength of mind which, when well directed, would have led to the highest attainments in moral worth, that will permit him to rest satisfied without the sympathy from others which he supposes is his due. Hence his pride must meet with constant mortification; for where will be found those who are willing to restrain their conduct continually by the rules to which he would bind them? where even are those who can enter into his views and feelings? pride then, even in a less extreme state, cannot be productive of happiness. But its ill effects are not thus limited. Blind to his own deficiencies, keen-sighted to observe the marks of merit in his own mind, the proud man throws continual impediments in his own progress towards worth of character. He sees not his deficiencies; how then can he supply them? He imagines his excellencies have mounted high in the scale of worth; how shall he purify them, when that which prevents their eminence is fostered by every comparison which he draws?

46. It has been said by one who appears to have possessed some knowledge of the world, that pride has at least this valuable effect, it tends to exclude all other failings; for the proud man places his standard so high, that he never feels his regard to his own dignity satisfied, till all inferior feelings are extirpated. This, we apprehend, is erroneous. It is supposing a mixture of pride and humility which will never appear in that mind in which pride is the ruling feature. The man who is proud of his own excellencies seldom sees that they are defective: besides, a desire of self-approbation is not pride, though too strong and unchastened a desire may tend to produce pride, because self-approbation is easily gained when made independent of higher sources.—There may be anomalies here, as in every other case of the operation of moral causes; but they are not sufficient to lead to the conclusion, that pride has the tendency to raise the mind above all other failings. Pride will operate differently in different minds, and the desire of self-approbation is, and ought to be, a primary motive in all the earlier stages of the moral progress: but if the mind rests satisfied with this approbation, that progress will soon be impeded; the standard will be lowered, rather than the conduct exalted; comparison with others will suggest numerous sources of self-gratification; and the mind, unable to rise to the heights which once appeared in view, now rather looks down upon the advances she has made, than upon the cliffs, which still tower very far above her. Here then is a stop to improvement; the desire which stimulated to improvement is gratified: and he, who, had he looked beyond himself, might have risen to the summit of excellence, now rests contented on the little pinnacle which his imagination has raised, looks with contempt on the crowds below, but, wrapt in the veil of conscious superiority, sees not that numbers whom he once saw below him have risen, and are rising, while he is lost to all improvement.

47. In minds possessed of some strength, pride may exist with little or no tendency to vanity. Firmly convinced of their own worth, they need not the sympathy of others; and if that respect which they deem their due is not given, it is the last

suggestion that would occur to their minds, that they had mistaken their due. But in those whose pride is less confirmed, or whose minds are more dependent, that pride leads to vanity. Their own high ideas of their own powers and attainments, require the sympathy of others to render them steady. Precisely as pride or vanity has the predominance, the want of such gratification will lead to greater independence, or greater submission; in the one case leaving the mind to the wayward wanderings of its own feelings, in the other forging more firmly the shackles which bind it to the world. Happy they who have learnt from various discipline, that higher approbation is to be sought for than the approbation of the world, or even than their own, and that neither possesses permanent value, except where sanctioned by that which, when once the ruling object of the mind, will make all others comparatively insignificant.

48. We have stated that both pride and vanity may exist independently of each other: from what we have advanced it appears, that pride will exist thus separately only in a vigorous mind, vanity, we would add, will be found independently of pride only in a weak mind. He who cannot rest satisfied without the sympathy of others, must be ever varying in his ideas, and fickle in his conduct. Without it he will possess no firmness, and with it no decision. The approbation which pride claims as its due, vanity seeks as a favour: if it receive it not, the vain mind desponds, for it has not learned to trust in itself.

49. It is difficult to form a comparative estimate of the injurious effects of pride and vanity. When the soil is good, both may produce good fruit: perhaps, however, pride presents the most effectual obstacles to improvement, and vanity tends most to render that improvement ineffectual. In the early periods of life the good opinion of others is the highest stimulus which the mind can receive, and, well directed, it has its full effect in prompting to the attainment of moral and mental excellence. The circle at first is narrow: the few friends on whom we depend for the various comforts and enjoyments of life, are those, whose good opinion forms our first object. If these are, fortunately for us, correct in their appreciation of worth, their good opinion is the source of future excellence, it prompts to the formation of the most valuable habits, and lays the foundation for that desire of honour, which afterwards raises the mind to Him whose approbation is happiness. If they make their approbation depend upon right conduct, and do not lavish their praise or their censure, but give it only where justly estimated praise or censure is due, the result is valuable; if they teach to value the praise of the wise and the good only, vanity will in time be brought within proper limits; but they do not do all, if they do not teach that the pleasure which they at present receive from their friends is afterwards to be chiefly sought for in that of their best friend, that his approbation is to be made the criterion of excellence, and that by this they must appreciate the worth of all other sources of honour. If indiscriminate vanity be not thus checked, the mind which seeks the good opinion of others will fall into the opinions and practices of others; unsteadiness of principle and of conduct must be expected, for that on which they are founded is variable as the wind. The stimulus of praise becomes necessary to happiness; and the mind is incapable of exertion where that praise is not to be obtained; is incapable of acting in opposition to the opinion of those whose censures it deems the worst of evils, whose praise it regards as the chief of goods.—The excessive desire of the good opinion even of the wise and good, is injurious to the mind. It enervates its powers of action, it renders it fickle and inconstant: it prevents from efforts leading to high utility, where those efforts may be misinterpreted: it checks the attention which should be paid to superior honour: and it prevents that ardent desire for the highest approbation, which should be made, as far as possible, the primary object of pursuit.

50. The virtue of humility is the most difficult to acquire of all the train, yet it is this which gives the true grace to the character. It is the characteristic of christianity, and it is in this respect that the christian so far excels the stoical system of morality: the whole structure of the latter was laid upon the foundation of human pride, and though frequently captivating to the imagination, which loves to view the elevated mind, yet it often affords a poor shelter to the children of humanity. Humility does not direct us to estimate ourselves lower than impartiality requires; but it is seldom that we need fear wandering into this extreme, except where it arises from that self-diffidence, which distrusts, merely because vanity has not yet lent its support. This excess of

diffidence is not unfrequently the cause of vanity; for the mind then feels the more eager desire to be well in the estimation of others, and, when their good opinion is obtained, fosters it with too great pleasure. Still however the frequent mortifications it meets with tends to lower it in its own estimation, unless by degrees it learns to set a value upon its own requisition, independently of the captious applause of others; and then it deviates into the opposite extreme of self-sufficiency and pride. Here a strong mind, not under religious culture, will rest; a weak one will probably be again driven to that support, on which it originally rested its self-approbation. If it do not return to its former state, the attentions which vanity received as a favour, pride claims as its right: and in both cases endless inquietude, envy, and resentment, are the almost necessary attendants.

51. The workings of vanity ought not to be viewed with too suspicious an eye in the early stages of intellectual and moral culture. Self-diffidence is almost necessary for that culture, and vanity we have seen is frequently the offspring of self-diffidence. Care however should be taken to prevent the love of praise from becoming a necessary stimulus to exertion. The stimulus should be lessened by degrees: and if done gradually, the habit which it was intended to generate will be formed, and the exercise of it continued, without this stimulus.—Praise is probably employed in education more than is desirable, because more than is necessary; perhaps the simple expressions of sympathy in successful exertions would answer every purpose. The employment of them may however be varied by circumstances; but it should always be kept in view, that praise should be little employed in the culture of moral worth; to that, approbation should be given indirectly, and when bestowed upon intellectual acquirements, it should be distinctly seen that these are not held in the same rank with the performance of duty. The young should frequently be led, if self-diffidence do not make this a bar to exertion, to contemplate those who have made greater attainments than themselves, and seldom to refer to those who are below them; in this, however, such cases should be adduced as will prevent, or rather avoid, the excitement of envy; and where emulation gives birth to envy, this should be carefully avoided. But, above all, they should be taught to be discriminate in their desire of approbation, and be led by degrees to seek for that approbation, which alone is certain, and which alone is independently valuable. The eager desire of the praise of men debases the motives, weakens the mental powers, and produces corroding inquietude; the ardent pursuit of the former will supply motives to action continually increasing in purity, will strengthen the mind for valuable exertion, and prepare it for permanent happiness.

Cultivation of Humility.

52. In order to cultivate the tender plant of humility, we must clear away the high ideas we have of our own excellencies. All thoughts which please are apt to recur frequently, and their contraries to be kept out of sight; hence, by dwelling upon these excellencies, they will be magnified; by keeping our imperfections out of view, they are diminished; and the same causes too frequently lead to keep in view the defects of others, and neglect the consideration of their excellencies: and thus pride, that is, too high an opinion of ourselves, and too low an opinion of others, must be generated. Now the only way to obtain a just opinion of ourselves is, to reverse this operation, and by express acts of volition dwell upon the excellencies of others and our own defects, and to pass by with little notice the defects of others and our own excellencies.—To cultivate humility, we must learn not to seek the applause of the world, but to acquiesce in the respect it pays us, however disproportioned this may be to the merit of the action under consideration. We should remember, that however beautiful the productions of nature and art which pass under our notice, it would be absurd to stay till long experience and accurate examination justified it, that they are unequalled in their kind: much less should we suppose this of those sources of honour which happen to be our lot, which are certainly magnified beyond the truth in our own eyes, from the interest we take in ourselves. —Humility will further be cultivated by receiving with readiness the censures and shame which we have deserved; by acquiescing under them, where we think we have not deserved them; and in this last case always to suspect our own judgment.—The frequent recollection, that all our valued qualities proceed from God; that we have nothing which we did not receive from him; and that there could be no reason in ourselves why he

should select us to perform the particular part he hath assigned us; and the application of this important truth to the real occurrences of our lives, must greatly accelerate our progress to humility and self-annihilation.

IV. ESTIMATE OF THE PLEASURES OF SELF-INTEREST.

(PHILOSOPHY, *mental*, § 79, 84.)

53. We ought not primarily to pursue the means of obtaining the pleasures of sensation, imagination, or ambition, because these pleasures themselves, from what we have already seen, ought not to be made a primary object of pursuit. The means borrow all their value from the end, by association; and if the original value of the end be not sufficient to justify our making them our primary object, the borrowed value of the means cannot.

54. Gross self-interest, or the treasuring up of the means of happiness from these sources of sensation, imagination, and ambition, bears a very near relation to ambition. Those who desire great degrees of riches, power, learning, &c. desire also that their acquisition should be known to the world: to be thought happy often constitutes a stronger motive for action than to be happy. The reason therefore which excludes ambition as a primary pursuit excludes self-interest also. Gross self-interest has a manifest tendency to deprive us of the pleasures of sympathy, and to expose to its pains. Rapaciousness extinguishes all sparks of good-will and generosity, and produces endless resentments and jealousies. And indeed a great part of the contentions and mutual injuries which we see in the world, arise because either one or both of the contending parties desire more than an equitable share of the means of happiness.—Besides, gross self-interest has a most painful and peculiar tendency to increase itself by the constant recurrence and consequent augmentation of the ideas and desires that relate to self, and the exclusion of those which relate to others.—This inconsistency of gross self-interest with sympathy, would be an argument against it barely upon the supposition that sympathy was one necessary part of our nature, which ought to have an equal share with sensation, imagination, and ambition: but as it now begins to appear, from the exclusion of those as primary objects, that more than an equal share is due to sympathy, the opposition between them is a strong argument against self-interest.—There is in like manner an evident opposition between gross self-interest and the pleasures of theopathy and the moral sense; hence, if those be admitted as essential parts of our nature, and especially when it is shewn that they ought to be made primary objects of pursuit, an insuperable objection arises against our making the pleasures of self-interest our primary objects.—Gross self-interest, when indulged, destroys many of the pleasures of sensation, and most of those of imagination and ambition; that is, many of those pleasures from which it takes its rise. This is peculiarly true and evident in the love of money, and it holds in a considerable degree with respect to other selfish pursuits. It must therefore destroy itself in part, as well as the pleasures of sympathy, theopathy, and the moral sense, with the refined self-interest founded upon them. And thus it happens, that in very avaricious persons, nothing remains but a sensual selfishness, and an uneasy hankering after money, which is a more imperfect state than that in which they were at their first setting out in infancy.—Men, in treasuring up the means of happiness without limit, seem to go upon the supposition that their capacity for enjoying particular species of happiness is infinite, and consequently that the power of enjoyment depends upon the stock of means which they amass. But our capacity for enjoying happiness is confined and fluctuating; and there are many periods during which no object, however grateful to others, can afford any pleasure, owing to the diseased state of our minds or of our bodies.—Further, it is evident, in part, that self-interested men are not more happy than others, whatever means of happiness they may possess. Experience appears to confirm the reasoning already adduced, but it certainly confirms this conclusion. Those who are continually aiming to treasure up the means of happiness, are in general remarkably miserable. The covetous man subjects himself to hardship, care, fear, ridicule, and contempt, and thus undergoes greater evils than what fall to the share of mankind upon an average.

55. Some degree of refined self-interest is the necessary consequence of the power of receiving the pleasures of sympathy and theopathy. He who has had

a sufficient experience of the pleasures of friendship, generosity, devotion, and self-approbation, cannot avoid the desire to have a return of them, when he is not under the particular influence of any one of them, merely on account of the pleasure which they have afforded. And if he have not advanced into very considerable purity of motives, will seek to excite those pleasures by treasuring up the means of them, and to keep himself in a disposition to use them, not from any particularly vivid love of his neighbour, or of God, or from a sense of duty, but entirely from the view of private happiness.—Refined self-interest is neither so common nor so conspicuous, in real life, as the gross self-interest. It rises late, and is never in any great magnitude in the bulk of mankind, though the want of the previous pleasures of sympathy, religion, and the moral sense, and in some it scarcely prevails at all; whereas gross self-interest rises early in infancy, and arrives at a considerable magnitude before adult age.

56. The objections which lie against making the pursuit of refined self-interest our ultimate object, though less obvious, do not appear less weighty than those which lie against gross self-interest. In the first place, the mind which has so far advanced towards perfection, as to make the means of obtaining the refined pleasures of religion and virtue the primary object, will be more likely, finally, to stop at this point than he who was guided by gross self-interest. There is less the appearance of deficiency, and less opposition between it and the claims of benevolence and piety; and as it leads to the performance of laudable actions, the conscience is too apt to give approbation where, if all that influenced the mind were brought into full view, nothing but self would be seen. Hence there is little inducement to refine the motives, and purify them from their baser alloy; and making self continually the motive, checks the natural progress of the affections to complete disinterestedness.

57. To act with a direct view to the pleasures of benevolence and piety, seems to carry with it a degree of selfishness little superior to that of the refined sensualist, who chooses from among the objects of his degraded taste such only as will give the least alloyed pleasures, and those of the most continued duration. It differs from his selfishness, in producing to society more valuable effects; but from what has been stated respecting the progress of the affections in *mental* PHILOSOPHY, it appears that it is very considerably below that state in which the affection is perfect: and we have already seen that it stops its progress towards that perfection. It may fairly be admitted in the commencement of a virtuous course as a step towards improvement; but if the mind be suffered to rest here, we cannot esteem its progress great.—In addition to these objections, some very forcible ones will appear among those which lie against acting with an explicit view to our greatest happiness on the whole, making even the highest least debasing, because least specific kind of self-interest, our ground of action.

58. Rational self-interest is certainly to be put upon a very different footing from the gross and refined; agreeably to which the scriptures promise general hopes and fears, and especially those of a future state, and inculcate them as good and proper motives: and they may, therefore, certainly be considered as auxiliary in our moral progress. But Christianity holds out still more refined motives, distinct from hope and fear,—the love of God and our neighbour, the law of our minds, &c. that is, the motives of sympathy, theopathy, and the moral sense. Rational self-interest will lead to the formation of these, and to the destruction of the impure motives to action; and precisely as far as it does this, it may be reckoned a virtue. When it tends to cherish the impure motives, or simply to obstruct the growth of the pure motives, then it must be considered as a vice. That we ought not to rest satisfied with that state in the moral progress, in which an explicit and direct view to the greatest general happiness or misery is made the primary motive to action, may be argued from the consideration, that a constant attention even to these most general hopes and fears would extinguish, by degrees, our love of God and our neighbour, and this especially by augmenting the ideas and desires which centre immediately in self to an undue height.—While our own happiness, even the most refined and general, is the explicit motive, benevolence and piety will never acquire that disinterestedness which will prompt to their respective course of conduct, without any exterior stimulus, simply by the impulse of the affection.—Rational self-interest will at times be present to the

mind even of those who have advanced highest in the scale of present excellence; and in the early stages of the moral progress, may be called in as a most careful auxiliary, and important support; but even this must be made subordinate to the cultivation of those affections, which are only perfect as they approach disinterestedness.

59. We shall conclude this head in the words of Dr. Reid, with a few alterations.—Though a steady pursuit of our own real good may, in an enlightened mind, produce a degree of virtue which is intitled to some approbation, yet it can never, while the mind rests with this explicit regard to self, produce the noblest kind of virtue which claims our highest love and esteem.—We account him a wise man who is wise for himself; and if he prosecute his end through difficulties and temptations, his character is far superior to that of the man who, having the same end in view, is continually starting out of the road, from an attachment to his appetites and passions, and doing every day what he knows he shall heartily repent.—Yet, after all, this wise man whose thoughts and cares are all centered ultimately in himself, who indulges even his social and divine affections only with a view to his own good, is not the man whom we cordially esteem, nor who possesses the noble elevation of mind which commands our admiration. Our cordial esteem and admiration are due, are given, only to him whose soul is not contracted within itself, but embraces a more extensive object; who loves religion, not for her dowry only, but for her own sake; whose benevolence is not selfish, but generous and disinterested; who, forgetful of himself, has the common good at heart, not as a means only, but as an end; who abhors what God and conscience condemn, however attractive its appearance; who chooses, without hesitation, what God and conscience approve, though surrounded with ten-fold dangers.—Such a man we esteem the perfect man, compared with whom, he who has no other aim than good to himself, is a mean and despicable character.—To serve God and be useful to mankind, without any concern about our own good and happiness, is probably beyond the pitch of human nature. But to serve God and to be useful to men, merely to obtain good to ourselves, or to avoid ill, is imperfect service, and not of that liberal nature which true devotion and real virtue require.

60. Though we might be apt to think, that he has the best chance for happiness who has no other end of his deliberate actions but his own good, yet a little consideration will satisfy us of the contrary. A concern for our own good is not a principle that of itself gives any enjoyment; on the contrary, it is apt to fill the mind with fear, and care, and anxiety. And these concomitants of this principle often give pain and uneasiness, which counterbalance the good they have in view. We may compare, in point of present happiness, two imaginary characters, the first, of the man who has no other ultimate end of his deliberate actions than his own good, and who has no regard to religion and duty but as means to that end: the second, of the man who is not indifferent with regard to his own good, but has another ultimate end, (perfectly consistent with it) a disinterested love of goodness for its own sake, or a regard to duty as an end. Comparing these two characters in point of happiness, that we may give all possible advantage to the selfish principle, we shall suppose the man, who is actuated solely by it, to be so far enlightened as to see it his interest to live soberly, righteously, and piously in the world, and that he follows the same course of conduct from the motive of his own good only, which the other does, in a great measure, or in some measure, from a sense of duty. The one labours for hire, without any love to the work; the other loves the work, and thinks it the most noble and the most honourable he can be employed in. In the first it is mortification and self-denial, to which he submits only through necessity; to the other it is victory and triumph in the most honourable warfare.—It ought further to be considered, that though wise men have concluded that virtue is the only road to happiness, and the commands of a benevolent Creator necessarily lead us to consider it as such; yet he who follows it only as a means to an end, and who obeys God only for the sake of the rewards he has attached to obedience, would, in all probability, be continually wandering from the direct path, and seeking for happiness where it was not to be found.—The road to duty is so plain, that the man who seeks it with an upright heart cannot greatly wander from it; but the road to happiness, (except where that confidence in the Supreme Being is formed, which supposes the pious affections to have become disinterested) would be found dark and intricate, full of thorns

and dangers, and therefore not to be trodden without fear, and care, and perplexity.—The happy man, therefore, is not he whose happiness is his only care; but he who with perfect resignation leaves the care of his happiness to his Maker, while he pursues with ardour the road of his duty. This gives an elevation to his mind which is real happiness; instead of care, and fear, and anxiety, and disappointment, it brings peace and joy. It gives a relish to every good we enjoy; it smoothes the brow of distress, calms the perturbed mind, and makes the pillow of suffering and of death the rest of happinesss.

V. ESTIMATE OF THE PLEASURES OF SYMPATHY.

(PHILOSOPHY, *mental*, § 85—88.)

61. We have now proceeded through and examined all those sources of happiness which do not coincide with what we established as the standard of comparison, the greatest ultimate happiness. We have seen, that if any of them be made the primary object of pursuit, happiness cannot be obtained; and that the greatest degrees of these pleasures are to be obtained, not by making them our primary object, but submitting ourselves to the guidance of benevolence and piety. We might hence alone be inclined to consider the inference a just one, that the affections of benevolence and piety, and those actions to which they prompt, should be made by us our primary object. We shall feel our ground more sure when we enter into the positive argument for these premises; and we now proceed to ascertain what rank the benevolent affections should have in our rule of life.—And here it is to be laid down as a principle, that the cultivation of these affections should be made a primary object of the pursuit for the following reasons.

62. Benevolence improves the inferior pleasures, by limiting and regulating them, as we have already seen in the course of our former investigations.—Again, the pleasures of benevolence unite and coincide with those of piety and the moral sense. That benevolence unites with piety is obvious; for by the love of the good we are led to love the source of goodness; and back again from the love of God to the love of all that he has made. The pleasures of benevolence are one principal source of the moral sense, and the moral sense in its turn improves and enforces them entirely.

63. The pleasures of benevolence are unlimited in their extent.—In order to shew that the pleasures of sensation did not deserve our primary attention, an extreme case was taken of a person who actually made them his primary object: in the same way suppose a person to take all opportunities of gratifying his benevolent desires, making it his study, pleasure, and constant employment, either to promote happiness, or to lessen misery. Now it is very obvious, that he would have a very large field for exercise, no less than the whole round of domestic and social relations. And if his benevolence were pure, and regulated by the dictates of piety and the conscience, he might, in general, expect success. And from the experience of those who have made the trial, it does not appear that the relish for its pleasures languishes, as in other cases, but gains strength by gratification; and they continue to please in reflection. The reason of this is obvious from the law of association; for since they are in general attended with success, and are consistent with and productive of the several inferior pleasures in their due degree, and are also further increased by the moral and religious pleasures, they receive fresh addition upon every gratification, and therefore increase perpetually, when the affections are cultivated as they ought to be.

64. The pleasures of benevolence are self-consistent.—All may share them without diminishing their mutual happiness. Harmony and mutual co-operation prevail among the benevolent; and benevolent actions have a tendency to excite correspondent actions indefinitely.—By degrees, when benevolence has arrived at its due height, all the sensibilities of the individual for himself will be more or less transferred upon others, by his benevolence and compassion for them. And in like manner, when our moral sense is sufficiently established and improved, and we are capable of being influenced to perform what is fit and right, by the consideration that it is so, our imperfect sensibility for others tends to diminish, by being compared with it, our exorbitant attachment to ourselves; at the same time that compassion takes off our thoughts from ourselves. And thus benevolence to a single person may ultimately become equal to self-interest, by this tendency of self-interest to increase

benevolence, and reciprocally of benevolence to lessen self-interest, though originally self-interest was indefinitely greater than benevolence; and thus we may learn to be as much concerned for others as for ourselves, and as little concerned for ourselves as for others.—It is not often that benevolence is thus heightened: perhaps in the strictest sense it can never reach this height in the present state; but take the case where there is a decided preponderance of benevolence over every feeling which bears the character of malevolent. It is not perhaps capable of proof, but certainly has decided probability, that in the circle in which each moves, and in the circle of the race at large, happiness decidedly preponderates. If the benevolent individual, though he do not see this balance of happiness clearly, yet has some comfortable general knowledge if it, he must be a greater gainer in the whole by his benevolence, because thus he has a source of constant gratification in the perception of such a preponderance of happiness among those in whose happiness he has learned to rejoice in some measure as in his own.

65. It will confirm our belief that the cultivation of benevolence should be made a primary pursuit of life, if we recollect that its pleasures lie open to all kinds and degrees of men, since every man has it in his power to benefit others, and since we all stand in need of each other's good offices.—Unlike the brute creation, we are dependent upon each other from the cradle to the grave, for life, for health, for convenience, for pleasure, for intellectual accomplishments, and are unable to subsist with comfort singly, or even in very small societies; and this may be considered as a mark of the superior excellence of man's social pleasures. All the tendencies of the events of life, ordinary and extraordinary, of the relations of life, of the various pleasures which have been enumerated, to connect us together, to connect accidental associations, and those forced upon us by the common situation of man, and his situation in society, into permanent affections, prove the same thing; so great, indeed, is this tendency, that two men without claims to the title of benevolent, can scarcely become familiarly known to each other, without conceiving some good-will, complaisance, compassion, and tenderness, for each other.—Further, we love, esteem, and assist the benevolent more than others: so that a benevolent action not only excites the receiver to a grateful return, but also the by-stander to approve and reward: and benevolence receives a hundred-fold, even in this world.—"But," says the excellent Hartley, "it would be endless to pursue this. Benevolence is, indeed, the grand design and purport of human life, of this probationary state; and every circumstance of human life, duly considered, must and does point to it directly or indirectly."

66. As it is now established that benevolence is a primary pursuit, it follows, that all the pleasures of malevolence are excluded, as direct obstacles to our happiness. The lower pleasures may all be made consistent with, and even subservient to, benevolence, by the limitations and power of it: but those of malevolence are quite incompatible with it. As far as malevolence is allowed, benevolence must be destroyed.—There is, however, this exception; where wishing evil to some disposes us to be more benevolent on the whole, (as in the case of what is called a just indignation against the vicious), it may somewhat aid the moral progress in the lower stages of benevolence. But it is exceedingly dangerous to encourage such a disposition of mind, by satire, invective, or dispute, however unworthy the opponent may be; for, fostered, it will soon wear the features of ill-will, will soon totally become rank malevolence.

67. We must not only forego the pleasures of malevolence, but patiently and resolutely endure the pains of benevolence, particularly those of compassion. But we shall not be losers on either of these accounts. The pleasures of the moral sense, which result from these virtues, will, in the first case, compensate for what we forego; in the last, overbalance what we endure. Besides, mercy and forgiveness are in themselves pleasures, and in the event productive of many others; and compassion generally leads us to such conduct as makes the afflicted to rejoice, and increases our disposition to rejoice with them.

68. As benevolence is thus supported by many direct arguments, there are many similar and apposite arguments to prove that malevolence is the bane of human happiness; that it occasions misery to the agent as well as the sufferer; that it is indefinitely inconsistent with itself, and with the course of nature; and that, consequently, it is impossible that it should subsist for ever. Now all these become so many indirect arguments for benevo-

lence, and urge us to make the cultivation and exercise of it the supreme pleasure and end of our lives.—In order to make this appear more fully, we have only to take a survey of human life, the reverse of what we have already attended to. Injuries are increased by mutual injuries, till at last mutual sufferings oblige both parties to desist: the increase and constitution of human nature give numberless admonitions to forbear; and the hand of every man, and the power of every thing, is against the malevolent. So that, if we suppose a number of beings to be purely malevolent, and consequently to have an indefinite number of enemies, they would first cease from their enmity on account of their mutual sufferings, and become purely selfish, each being his own sole friend and protector; and afterwards, by mutual good offices, endear themselves to each other; so that at last each of them would have an indefinite number of friends, and thus would be indefinitely happy.—This is, in part, mere supposition; but its obvious correspondence with what we see and feel in real life, is a strong argument both of the infinite goodness of God, and consequently of the tendency of all beings to unlimited happiness through benevolence. For the beings whom we have supposed to set out with pure malevolence, could no more rest at pure selfishness, or any other intermediate point, than they could at pure malevolence.—And thus the arguments, which exclude pure malevolence, necessarily infer that pure unlimited benevolence should be the ultimate object of man.

Culture of Benevolence.

69. In order to augment the benevolent, and suppress the malevolent affections, we should diligently practise all such acts of friendship, generosity, and compassion as our abilities of any kind extend to; and rigorously refrain from all sallies of anger, resentment, envy, jealousy, &c. For though our affections are not directly and immediately subject to the voluntary power, yet our actions are; and, consequently, through them, our affections. He that at first practises acts of benevolence by constraint, and continues to practise them, will at last have associated with them such a variety of pleasures, as to transfer a great instantaneous pleasure upon them, and produce in himself the affections from which they naturally flow. In the like manner, if we abstain from malevolent actions and expressions, we shall dry up the ill passions which are the sources of them.

70. With the same objects in view, it will be of great use, frequently, to dwell upon the great pleasures and rewards attending on benevolence; and also upon the many evils, present and future, to which the contrary disposition exposes us. For thus we shall likewise transfer pleasure and pain by association upon these dispositions respectively; and rational self-interest will be made to produce pure benevolence, and to extinguish all kinds and degrees of malevolence.

71. Frequent and fervent prayer for others, friends, benefactors, strangers, and enemies, has a very great and decided tendency to augment benevolence, and to extinguish malevolence. All exertions of our affections cherish them; and those made under the more immediate sense of the divine attributes, have an extraordinary efficacy, in this respect, by mixing the love, awe, and other exalted emotions of the mind attending our addresses to God, with our affections towards man, so as to improve and purify them. Petitions for the increase of our benevolence, and the suppression of our malevolence, have the same tendency.—Again, all meditations upon the attributes of God, and particularly upon his infinite benevolence towards all his creatures, have a strong tendency to refine and augment our benevolent affections.—And, lastly, the frequent consideration of our own unworthiness, our entire dependence upon God, &c. raises in us compassion for others, as well as concern and earnest desires and prayers for ourselves. And compassion, in this imperfect probationary state, is an essential and principal part of our benevolent affections.

Rules for the Conduct of Men towards each other in Society.

PRACTICAL BENEVOLENCE.

72. Having now established the position, that benevolence should be a primary pursuit of men, it follows that we should aim to direct every action, so as to produce the greatest happiness and the least misery in our power. This is the rule of conduct towards our fellow-creatures, which universal, unlimited benevolence inculcates.—But the application of this rule in real life, is attended with considerable difficulties and perplexities. It is impossible for the most sagacious and experienced to make any very accurate

estimate of the future consequences of particular actions, so as, in all the variety of circumstances which occur, to determine justly which action would contribute most to augment happiness and lessen misery. Instead, therefore, of this very general rule, we must substitute others less extensive, and subordinate to it, admitting of a more commodious application. Whatever rules are laid down for this purpose, it is obvious, that their coincidence must add strength to each; and that when they differ, or are apparently opposite to each other, this difference or opposition must moderate or restrain their application. On the whole, however, the general result will prove the best direction for promoting the happiness, and lessening the misery, of others.

73. Hartley lays down the following ten subordinate rules: "1. That we obey the scripture precepts, in the natural, obvious meaning of them.—2. That we should pay great regard to the dictates of our own moral sense, and to those of others. —3. That in deliberate actions we should weigh the probable consequence on each side.—4. That we are not to be guided implicitly by the mere impulse of compassion and good-will: yet that great regard should be paid to them in our conduct.—5. That we should place ourselves in the situation of the persons concerned. —6. That persons in the near relations of life, benefactors, dependants and enemies, seem to have in most cases, a prior claim to strangers.—7. That benevolent and religious persons have, all other things being equal, a prior claim to the rest of mankind.—8. That we should contribute, as far as lies in our power, to the moral and religious improvement of others.—9. That we ought to pay the strictest regard to truth, both in our affirmations and in our promises.—10. That we ought to obey the civil magistrate and the laws of the community." These rules we think truly unexceptionable; and we shall follow the order of Hartley, enlarging on some of them as we proceed. It appears, however, to be desirable, that we first enter a little into the consideration of the necessity of our acting upon general rules of conduct.

74. To show that general rules of conduct are necessary in the present state of human nature, it is simply requisite to answer the question, what would be the state of things without them? We should then be under the necessity of calculating in every case that comes before us, on what side the good or evil attending certain actions preponderates. In fact, our lives would be a series of thought, instead of what they were designed to be, a series of action. A total stop would be put to the business of life, and instead of regularity and consistency in a person's conduct, we must expect to find nothing but a series of actions, constantly proceeding from no steady principle, and marked with all the features of inconsistency.—But further, we are led to the same conclusion, when we consider our ignorance of futurity, and the little time and leisure possessed by the generality of men for the investigation of the consequences of their actions. We not unfrequently are unable precisely to trace even those consequences which are immediate and apparent, still less those which arise silently and gradually in the lapse of time. The consequences of our actions may last, when the agents have long ceased to exist as children of mortality. Our actions may influence others; our deviations may produce more extensive deviations, of which we have no knowledge. Perhaps there is scarcely an important action in our lives, the consequences of which are confined to ourselves, or even to our own sphere of observation. Besides, if we were unable to lay down general rules for conduct, and were obliged to decide upon each action as it occurred, it is scarcely possible that we should avoid the influence of heated feeling; and seldom should we possess that abstraction of mind, which would enable us to leave the present out of consideration, and view with calmness and impartiality the tendency of our actions. Innumerable are the cases in which interest or passion paint in vivid colours the course to which they prompt, and throw into the back ground, and render almost imperceptible, the dangers which should induce us steadily and perseveringly to avoid it: hence, we may lay it down as indispensibly necessary, that there should be general rules for conduct, and consequently a deviation from a general rule must of itself be an evil.

75. Yet there are cases in which the general rule seems to fail of application; in which the immediate consequences are such as benevolence, equally with self-interest, seems to reject. In such cases our inquiry should be, what would be the consequence if the conduct became general, which, in my individual case, seems to be so favorable to happiness, social or private. And if we have reason to believe that it would be injurious, our

belief, in the beneficial tendency of the individual action, should be considered as less founded; we should perhaps in all cases, certainly in most, unhesitatingly sacrifice much private advantage, and even the apparent good of others, to consistency in our adherence to what on the whole must be best. We may indeed think that the consequences which would arise from the general adoption of our individual conduct, ought not to be attributed in any way to us; but we should recollect that if we once break down the barrier, however small the breach, the advantage gained by the enemy is evident. In fact, when once we remove the limits which reason and revelation fix, we usurp to ourselves the privilege of the Almighty, and cannot fail to prove our own weakness. It is on this ground, and with great justice, that Paley considers crimes as deriving their criminality, not so much from the consequences of the individual action, as from the consequences which would result from such actions becoming general. Thus the man, who by the forgery of a one pound note, may probably render no individual injury worth estimating in the punishment of a fellow creature; and another, who by the forgery of a large bill, without direct intention, ruins an individual family, are both equally culpable in the eye of reason, and perhaps as far as punishment is beneficial to others, he who has forged the one pound note deserves greater severity of punishment, because the means of committing his depredation on society are much more practicable than in the other case. But in both it is not the individual injury sustained that is to regulate the proportion of demerit, but the consequences which would follow the total destruction of commercial intercourse and of mutual confidence.

76. By the application of this important principle, much of that obscurity is dissipated, which seems to involve some questions on morals which are intimately connected with the well being of society.—Many of those violations of veracity, for instance, which even benevolence seems to authorise, will appear to be direct deviations from the soundest principles of morality, and consequently to be unauthorised by benevolence, when viewed in their fair extent, however much the immediate consequences may seem to demand them. There is, however, one restriction to this rule, which seems to be necessary, in order to enable us fully to submit to its influence. It is, whether the probability of our conduct being generally adopted, be sufficient to counterbalance the advantages or disadvantages which would arise if such general adoption took place. Let us apply it to the case I have already adduced of the violation of truth. Now it is very obvious that in most cases in which there is any strong tendency to such violation, it arises from the desire to remove or avoid some ill attending our adherence. Hence the temptation to repetition, either by ourselves or others, will always be sufficiently powerful, if no counterbalancing considerations prevented to induce us to deviate from truth, and therefore the probability of our conduct becoming general, is indefinitely great, and consequently indefinitely strengthens the reasons we draw against such deviations, from their ill effects if they become general. On the other hand, it is obvious, that if all who could afford it gave to the poor to the extent of their ability, the sources of industry would be dried up, and society would immediately fall into such confusion, that if the ideas of punishment were not very enlightened, alms-giving might be deemed a capital crime. Hence we might argue from the general principle already laid down, that we ought not to give at all; and we think Paley defective in appearance at least for having furnished no clue to a solution of the difficulty. It is immediately solved by the restrictive rule which has been laid down; what is the probability that alms-giving will become general, or even so general as to produce the feared effects in a small degree? If this be very small, we have nothing more to do than to consider which is the best direction for our superfluities, and give, with the certainty that our conduct will not become so universal as to render it injurious instead of beneficial. We now proceed, following Hartley as our outline, to consider those rules of conduct by which we may safely guide ourselves through the intricacies of human life.

77. The first rule is, that we obey the Scripture precepts in the natural obvious meaning of them.—The Scripture precepts are indeed in themselves the rule of life. There is, however, the same kind of difficulty in applying them accurately to particular cases, as in applying the above-mentioned most general rule, by means of an estimate of the consequences of actions. It is impossible in many particular cases to determine precisely the connection of the action with the precept. However, unless it would

obviously lead a person to act in opposition to some or other of the following rules, it is the safest way, in the particular circumstances of real life, to recollect the Scripture precepts, and follow them in their first and most obvious sense. *

78. Secondly, great regard must be had both to the dictates of our own moral sense, and that of others. It is remarked, with great justice, by Dr. Aikin, that, in a mind whose moral powers have been cultivated, second thoughts are seldom the best. The first are the impulse of well-regulated feeling, and are produced instantaneously, without attention to all the petty suggestions of self, which crowd themselves in various ways into our minds, and by leading to doubt, and then aided by inclination to disobey, prevent the efficacy of the conscience, and throw a mist over the before clear directions of duty.—With respect to the moral sense of others, two motives should induce us to regard its dictates. The one is purely benevolent: we ought not to throw any impediment in the way of the duty of others: the other is, that prudence and humility direct, that we use the experience and the feelings produced by great moral culture, as guides of our own conduct.

79. Thirdly, it is very proper that, in all deliberate actions, we weigh, as well as we can, the probable consequences on each side, and suffer the balance to have some influence in all cases, and particularly where the other rules do not interfere, or where they fail of application. But they are generally the dictates of self-interest and pride, to be determined by our own judgments as to consequence, in opposition to rules of duty.

80. Fourthly, The impulse of the more instantaneous emotions of good-will and compassion will not always furnish a sufficient guide; at the same time they ought to have great regard paid to them, lest we contract a philosophic hardness of heart, by pretending to act upon higher and more extensively benevolent views than vulgar minds, or the more feeling sex, &c. Some, however, carry this much too far on the other side, and encourage many public mischiefs through a false, misguided tenderness to criminals, persons in distress through present vice, &c. When feeling is thus made the guide of conduct, he who can best play upon the sympathy, and best decorate his tale of woe, will meet with a reward for his ingenuity, due only to the modest merit which shrinks from the public view, or at least obtrudes not itself upon our notice. The injury done to society at large by this ill-directed compassion, so generally prevalent, because it gratifies without trouble, is very great indeed; and while we have it in our power to cultivate compassion and sympathy, by the view and the relief of real misery and suffering worth, the desire of such cultivation is scarcely sufficient to exculpate us, when our minds have acquired some degree of comprehension, from the charge of preferring a selfish, indolent gratification to the good of others. To use the words of the elegant Stewart, "the dictates of reason and conscience inform us, in language which it is impossible to mistake, that it is sometimes a duty to check the most amiable and pleasing emotions of the heart; to withdraw, for example, from the sight of those distresses which stronger claims forbid us to relieve, and to deny ourselves that exquisite luxury which arises from the exercise of humanity."

81. Fifthly, the rule of placing ourselves in the several situations of the persons concerned, and inquiring what we should then expect, is of excellent use for directing, inforcing, and restraining our actions, and for producing in us a steady, constant sense of what is fit and equitable.—This rule is so comprehensive, that it may be called the sum and substance of Christian morality. It has been objected by some, that it teaches nothing, for it shows not what justice is; and that it is an improper rule, for we ought not to do to others what we should wish them to do to us, but what we may justly expect them to do to us. But this is no real objection. The object of the rule most probably is, to serve as a criterion of duty which should counteract the impressions of self. We never need fear lest we should carry our imaginary substitution to too great a length, and think of what passion or interest might lead us to expect: when not under the influence of passion or interest, it is more than probable that we shall be guided sufficiently accurately. Our only danger is, lest we should not go far enough, that we should admit of this principle, which, if circumstances had been real, ought to have had no place.—This rule of duty, says Dr. Reid, comprehends every rule of justice without exception. It comprehends all the relative duties, arising either from the more permanent relations of parent and child, of master and servant, of magistrate and subject, of husband and wife, or from the more tran-

sient relations of rich and poor, of buyer and seller, of debtor and creditor, of benefactor and beneficiary, of friend and enemy. It comprehends every duty of charity and humanity, and even of courtesy and good manners.—He who acts invariably by this rule, will never deviate from the principle of his duty but from an error of his judgment.

82. The word justice (says Mr. Stewart, in his "Outlines"), in its most extensive signification, denotes that disposition which leads us, where our own temper, or passions, or interest, are concerned, to determine and to act, without being biassed by partial considerations. In order to free our minds from the influence of these, experience teaches us either to recollect the judgments we have formerly passed in similar circumstances, on the conduct of others; or to state cases to ourselves in which we, and all our personal concerns, are entirely left out of the question.—Justice operates, first, in restraining the partialities of the temper and of the passions; and, secondly, in restraining the partialities of selfishness, where a competition takes place between our interests and those of other men. These two modifications of justice may be distinguished from each other, by calling the first candour, the second integrity or honesty. The professor's remarks on the subject of candour are very valuable and important; and we deem no apology necessary for laying them before our readers. This disposition, he observes, may be considered in three points of view; as it is displayed in judging of the talents of others; in judging of their intentions; and in controversy.

83. The difficulty of estimating candidly the talents of other men arises, in a great measure, from the tendency of emulation to degenerate into envy. Notwithstanding the reality of the theoretical distinction between these dispositions of mind, it is certain that in practice nothing is more arduous than to realize it completely; and to check that self-partiality, which, while it leads us to dwell on our own personal advantages, and to magnify them in our own estimation, prevents us either from attending sufficiently to the merits of others, or from viewing them in the most favourable light. Of all this a good man will soon be satisfied from his own experience; and he will endeavour to guard against it as far as he is able, by judging of the pretensions of a rival, or even of an enemy, as he would have done if there had been no interference between his claims and theirs. In other words, he will endeavour to do justice to their merits, and to bring himself, if possible, to love and to honour that genius and ability which have eclipsed his own.—Nor will he retire in disgust from the race, because he has been outstripped by others, but will redouble all his exertions in the service of mankind; recollecting, that if nature has been more partial to others than to him in her intellectual gifts, she has left open to all the theatre of virtue; where the merits of individuals are determined, not by their actual attainments, but by the use and improvement they make of those advantages which their situation has afforded them.

84. Candour in judging of the intentions of others is a disposition of still greater importance.—It is highly probable that there is much less vice, or criminal intention, in the world, than is commonly imagined; and that the greater part of the disputes among mankind arise from mutual mistake, or misapprehension. Every man must recollect many instances in which his motives have been grossly misapprehended by the world; and it is reasonable for him to allow that the case may have been the same with other men. It is but an instance then of that justice we owe to others, to make the most candid allowances for their apparent deviation, and to give every action the most favourable construction it can possibly admit of. Such a temper, while it renders a man respectable and amiable in society, contributes perhaps more than any other circumstance to his private happiness.

85. Candour, in controversy, implies a strong sense of justice, united to a sincere and disinterested love of truth. It is a disposition of mind so difficult to preserve, and so rarely to be met with, that the most useful rule, perhaps, to be given with respect to it, is to avoid the occasions of dispute and opposition. A love of controversy indicates not only an overweening vanity, and a disregard for truth, but in general, perhaps always, it indicates a mediocrity of genius; for it arises from those feelings of envy and jealousy which provoke little minds to depreciate the merit of useful discoveries. He who is conscious of his own inventive powers, and whose great object is to add to the stock of human knowledge, will reject unwillingly any plausible doctrine till after the most severe examination; and will separate with patience and temper

the truth it contains from the errors that are blended with them. No opinion can be more groundless, than that a captious and disputatious temper is a mark of acuteness. On the contrary, a sound and manly understanding is, in no instance, more strongly displayed, than in a quick perception of important truth, when imperfectly stated and blended with error: a perception which may not be sufficient to satisfy the judgment completely at the time, or at least to enable it to obviate the difficulties of others; but which is sufficient to prevent it from a hasty rejection of the whole, from the obvious defects of some of the parts. The effects of controversy on the temper, although abundantly sensible even in the solitude of the closet, are more peculiarly adverse to the discovery of truth in those disputes which occur in conversation; and which seldom answer any purpose, but to rivet the disputants more firmly in their errors. In consequence, indeed, of such disputes, the intellectual powers may be sharpened, and original hints may be suggested; but few instances are to be found, in which they do not mislead the disputants to a still greater distance from truth than before, and render their minds still more inaccessible to conviction.

86. Sixthly, persons in the near relations of life, benefactors, dependants, and enemies, seem to have in most cases a prior claim to strangers. General benevolence arises from the cultivation of the particular sources of it. The root must therefore be cherished before we can expect the branches to flourish, and the fruit to arrive at its perfection. Attention to this rule leads us to avoid all those opinions, which attempt to found universal upon the ruin of confined benevolence: however specious, they may appear they are false, because they counteract the moral improvement of man by checking it at its origin. We particularly refer to those which Godwin has advanced in his work on Political Justice. His most general principle is, that every individual exertion should be directed so as to produce the greatest possible sum of good to the species. Hence, that if we have the power to save the life or increase the happiness of one or two fellow creatures, we owe our exertions to him who is useful, and perhaps extensively useful to society, in preference to him who is an useless, or perhaps injurious member of society. The claims of self are excluded by the general principle. "What magic," says Godwin, "can there be in the word *my*, which should change its operation?" Hence the claims of confined charities ought not to oppose the deductions from the general principle. Hence it is not our business, in the direction of our benevolent exertions, to consider what is the relation in which the individual stands to us; but that in which he stands to society. Not, is he my parent, relative, friend, or benefactor; but, is he a worthy or a worthless member of society. Godwin's errors are the more injurious, because they appear to be the errors of benevolence; they result from the inaccurate extension and application of principles which in themselves are indisputable. Whenever private interest interferes with the public good, private interest is to be sacrificed; and this, whether our own immediate good is the object, or the good of those who are intimately connected with us, by some of the natural bonds; that is, those which arise in the mind by the laws of our constitution. That the conduct dictated by confined charity is to yield to general good, cannot be disputed; but that we are in all cases to act totally independently of a regard to those confined charities, is a position which will not bear the test of experience nor of the mental constitution of man. In the first place, benevolence never could arise in the human soul, but through their medium. Love to others is founded on feelings originally personal, then it embraces the narrow circle of our immediate friends and acquaintance, and then perhaps there is little difficulty in extending it to those who bear with us the relation of children to the great parent of mankind. But before we can form the desire to do good to all men, we must have formed the desire to do good to some men; and though the desire of doing good to some, may be of that confined nature which would lead to the promotion of their aggrandisement and happiness, at the expense of those of others, yet the confined charities form too important a part in the great system, to be on this account rejected, as not being on the whole safe guides. We may lop off the excrescences, but it would be folly to destroy the root. But, secondly, admit the formation of the feelings of general benevolence independently of the private charities, it is obvious, that without long culture and enlarged views, the general feelings cannot acquire the vividness, which, by their frequent recurrence and particularity, the more confined feelings can. Hence the removal of misery

would be left to those who had thus cultivated the extensive affections, and consequently the means of removing it must be most materially diminished. Thirdly, it would leave no rule for conduct upon which any one could act. If we are to be determined in our acts of benevolence, particularly in cases of immediate urgency, merely by the consideration of the utility of the individual to society, our lives would be a continual series of calculation, and, in general, of erroneous calculation. Who is there capable of accurately appreciating the worth of the individual? Our ideas are, in general, formed merely upon the appearances which strike our attention, and force us to observe them. The silent efficacy of example and private exertions to remove misery, and still more to remove or prevent vice, the parent of misery, are in general known only to Him who seeth in secret. Even in cases where much is obvious, what diversity shall we find in opinion? and where the co-operation of individuals for the benefit of others is necessary, how improbable that they should have formed the same standard.

87. But admit that the cases are clear, that the person whom we are about to leave to death is, obviously and decisively, a less important member of society than he whom we attempt to save, if we violate none of those feelings which rise up in the human frame altogether independently of the will of the individual, there can be no hesitation; but suppose that our proposed conduct will violate them—let it first be considered, that they are not only necessary to the culture, nay even to the formation of individual benevolence, but to the well ordering, perhaps to the very existence of society. Take the strongest case, suppose the filial and parental affections to be annihilated, (and it is absurd to justify and lay down as just, that conduct which, if not counteracted by the eternal laws of our frame, would lead to such annihilation, if that annihilation itself be not an object of desire), suppose these affections annihilated, and the heart shrinks from the picture. The claims of the helpless infant upon the parent would be rejected; and, if enlarged views of duty to society did not induce the parent to think that he had better remove from existence a being who would be a burden to others and himself, and who probably would not be educated so as to be wise and happy, there would arise constant discouragements, which would effectually prevent those steady uniform endeavours to cultivate the mental and moral powers, which are necessary to attain the object; and if the evil did not soon eradicate itself, man, if he existed, would gradually sink to the level of the brute. But if the parental affections existed not, neither would the filial. Here it is that the rudiments of good-will are formed in the infant breast; here it is that the being who is to love all mankind begins his career of love: here is the source of that ardent disinterested benevolence which carries the individual out of himself, which leads him to forget himself and all his immediate interests, and view only the good of others. Can it be supposed that this highly cultivated benevolence is in opposition to that more confined affection from which it sprung? No, we see it modifying its direction, but never annihilating it. On the contrary, it may be justly affirmed, that the confined affections become more inwrought in the frame, as universal benevolence becomes more and more a ruling feature of the mind; and it must, for universal benevolence is but the sum total of all the confined affections, extended by the hand of piety.

88. We have before mentioned, that there are two considerations upon which we ought to act, in cases where we are left to be guided by the views of the consequences of our actions. The first is, what would be the consequence if our conduct became general? the next, what is the probability of this extension of our conduct? Wherever the claims of the confined affections are in direct opposition to the dictates of the enlightened conscience, there can be no room for doubt, though we ought to be careful that our departure from their claims not only is, but, if possible, shall appear to be, demanded by these dictates; but we are, even in cases which, independently considered, are obvious, to take into consideration the evil that will result from a breach of those affections. There are some affections, which not all the efforts of philosophy could succeed in eradicating; vice may do it, and heedless levity, but the calm exertion arising from a view to utility never could. We refer to the parental affections. Hence it is probable, that a sacrifice of them to the public good, would be productive of much less injury, than a sacrifice of the filial affections, which are less urgent and lasting. Hence, though we should condemn the parent who left his son to perish in the flames, while he endeavoured to save the

life of Fenelon, and should require strong proof that the parental affections existed in him in their due force; yet we should doubly condemn the son, who in such a case left his father to perish. Godwin's principles, if carried to their fair extent, would destroy society; but we do not consider his errors as more than the errors of judgment. We suppose that the ardour of general benevolence misled him, and that in his wish to make its dictates paramount in the human breast, he forgot, or rather did not observe, that he was aiming to counteract the most essential laws of the human frame. It is one of those numerous instances in which an acquaintance with the human mind is necessary; had Godwin attended to its laws, it is reasonable to hope that he never would have given a theory to the world, which, even a slight acquaintance with its practicability and effects, should have consigned to oblivion.

89. Seventhly, benevolent and religious persons have, all other things being equal, a prior claim to the rest of mankind. Natural benevolence itself teaches this, as well as the moral sense. Two reasons strongly inforce this; in the first place we thus do what we can towards the promotion of goodness, we add something to the strength of the motives which exist, even in the present life, for steady adherence to the practice of virtue. If it be our aim to remove misery without discrimination, we in some degree break down the barriers of virtue; we cannot remove all; therefore let our efforts be directed so that they shall tell as completely as possible, and it is obvious that this will be most the case, where what we do discourages vice in all its shapes. If indolence be secure of relief from that pressure which it places upon itself, indolence will be increased; if the appearance of misery be the only passport to our assistance, vice will be continually receiving encouragement.—But it is not merely with a view to the relief of actual misery that discrimination is important; it is equally important with respect to the extension of the means of doing good. We may confidently expect all the opportunities and powers we can commit to others will be most serviceable in the hands of those whose habits are formed upon the model of benevolent piety.—In all cases, however, especially while our benevolence is incipient, we are in some measure to be guided by its mere impulse.—It is one important consequence of doing good to others, that we do good to ourselves, we cultivate our benevolence, and with it cultivate our happiness. But that benevolence will be found to rest upon the surest footing, which is made to prompt to exertions which shall not interfere with the most extensive interests of man.

90. Eighthly, since the concerns of religion and a future state are of infinitely more importance than those which relate to this world, it should be our most earnest object to contribute, as far as in us lies, to the moral and religious improvement of our fellow-creatures. In various ways we have this power; and this is a field in which all can, more or less, employ their talents. Here no effort can be altogether thrown away; at least no effort will be prejudicial; and if to others they will be useless, their effects return to our own bosoms.

91. Ninthly, we ought to pay the strictest regard to truth both in our affirmations and promises. There are very few instances where veracity of both kinds is not evidently conducive to the public good, and falsehood in every degree pernicious. It follows, therefore, that, in cases where appearances are otherwise, the general regard to truth, which is of so much consequence to the world, ought to make us adhere inviolably to it; and that it is a most dangerous practice to falsify, as is often done, from false delicacy, or even from those motives which border upon virtue. The harm which these things do, by creating a mutual diffidence, and tendency to deceive, is incalculable; and perhapsin no instance to be counterbalanced by the present good effects assigned as the reason for their practice.

92. Tenthly, obedience to the civil magistrate, and to the laws of the community, is a subordinate general rule of the greatest importance.—It is evidently for the public good that every member of a state should submit to the governing power, whatever that be. Peace, order, and harmony result from this in the general; confusion and mischief of all kinds from the contrary. So that, though it may, and must be supposed, that disobedience in certain particular cases will, as far as the single act and its immediate consequences are considered, contribute more to the public good than obedience, yet as it is a dangerous example to others, and will probably lead the person himself into other instances of disobedience afterwards, disobedience becomes in every case, upon the whole, of

a tendency destructive of the public welfare. We ought, therefore, in consequence of this rule, to respect all persons in authority; not to pass hasty censures upon their actions; to make candid allowances on account of the difficulties of government, the bad education of princes, and of persons of high birth, and the flattery and extraordinary temptations with which they are surrounded; to observe the laws ourselves, and to promote the observance of them where the penalties may be evaded, or are found insufficient; to look upon property as a thing absolutely determined by the laws, so that, though a man may, and ought to rescind from what the law would give him out of compassion, generosity, love of peace, view of greater good upon the whole, &c.; yet he must never in any way evade, strain, or do violence to the laws, in order to obtain what he may think his own according to equity: and whenever he has offended, or is judged by lawful authority to have offended, he must submit to the punishment, whatever it be.

93. Other rules, beside the ten foregoing, might be assigned, and these might be expressed in a different way. "I have put down," says Hartley, "those which appear to be in fact the chief principles of social conduct to wise and good men. They must all be supposed to influence and interpret each other. Let a man only divest himself as much as possible of all selfish regards, and he will generally find some point, and that without much difficulty, or perplexity, in which all these rules unite to produce the greatest good upon the whole, to all persons concerned."

94. Though our plan and limits will not allow of our entering at length into the duties arising from the particular relations of social life, yet we deem the observations of Hartley on the subject of the parental relation so important, that we shall make an abstract of his leading statement. The principal duty of the parental relation is, the giving of a right education, or the imprinting such associations on the minds of children, as may conduct them safe through this world, to a happy futurity. In the latter respect there can be no doubt, because religion must on all hands be allowed to be the one thing necessary; and, in the course of these investigations respecting the primary pursuit of life, it appears that it contributes as certainly to give us the maximum of happiness in this world, at least the fairest prospect of it, as to secure it in the next: so that a parent ought to inculcate it in every point of view. The chief errors of education are owing to the want of a practical persuasion of this point; or, to a false tenderness or opinion on the part of a parent, by which he is led to believe that the object does not require, in the case of his child, frequent corrections and restraints, with perpetual encouragements and incentives to virtue, by reward, example, advice, books, conversation, &c. When due care is taken from the first, little severity would ordinarily be necessary; but in proportion as this care is neglected in the first years, a much greater degree of care, with high degrees of severity, both bodily and mental, become absolutely necessary to preserve from misery both here and hereafter. Affectionate parents should, therefore, labour, from the earliest dawnings of understanding and desire, to check the growing obstinacy of the will; to curb all sallies of passion; to impress the deepest, most amiable, reverential, and awful impressions of God, a future state, and all sacred things; to restrain anger, jealousy, and selfishness; to encourage love, compassion, generosity, forgiveness, gratitude; to excite, and even oblige, to such industry as the tender age will properly admit. For one principal end and difficulty of life is, to generate such moderate, varying, and perpetually actuating motives, by means of the natural sensible desires being associated with, and apportioned to, foreign objects, as may keep up a state of moderate cheerfulness, and useful employment, during the whole course of our lives: whereas sensual, blind, and uninformed desire, presses violently for immediate gratification, is injurious to others, and destroys its own aims, or, at the best, gives way only to spleen and dissatisfaction.

VI. ESTIMATE OF THE PLEASURES OF THEOPATHY.

(PHILOSOPHY, *mental*, § 89—91).

95. We proceed now to the important inquiry respecting the theopathetic affections, what regard they claim from us in our formation of the rule of life. And here it appears that the love of God should be our primary pursuit and ultimate end, because it regulates, improves, and perfects all the other parts of our nature, and affords a pleasure superior

in kind and in degree to all the rest.—We have already seen the influence of the precepts of piety on the four inferior classes of human pleasures, those of sensation, imagination, ambition, and self-interest; but the precepts of piety are those which teach us what homage of our affections and external actions ought to be addressed to the Deity in a direct and immediate manner. Now all the affections enjoined by those precepts, terminate ultimately in the love of God, which therefore may be used in the same situations in which the term precepts of piety has been employed.—But in addition to this, it is obvious in a shorter way. The perpetual exertions of a pleasing affection towards a being who is infinite in power, knowledge, and goodness, and who is also our friend and father, cannot but enhance all our joys, and alleviate all our sorrows; a sense of his presence and protection will restrain all actions which are excessive, irregular, or hurtful; will support and encourage us in all such as are of a contrary nature; and will infuse such peace and tranquillity of mind as will enable us to see clearly, and act uniformly. The perfection therefore of every part of our natures must depend upon the perfection in which the love of God, and a constant sense of his presence, have obtained possession of the mind.

96. With respect to the support and regulation afforded by piety to benevolence, it may be observed, that the love of our fellow men can never be free from personality and selfishness, until we are able to view all things in the relation which they bear to God. If the relation to ourselves be made the point of view, our prospects must be narrow, and the appearance of what we do see, distorted. When we consider the scenes of vanity, folly, and misery, which present themselves to our view from this point; when we are disappointed in the happiness of our friends, or feel the resentment of our enemies; our benevolence will begin to languish, and our hearts to fail us; we shall complain of the corruption and wickedness of that world which we have hitherto loved, with a benevolence merely human, and shew by our complaints, that we are strongly tinctured with the same corruption and wickedness. This is generally the case with young and unexperienced persons in the beginning of a virtuous course, and before they have made advances in piety. The disappointments which human benevolence meets with, are sometimes apt to incline us to call the divine goodness in question. But he who is possessed of a full assurance of this, who loves God with his whole powers, as an inexhaustible fountain of love and benevolence to his creatures, at all times and under all circumstances, as much when he chastises as when he rewards, will learn thereby to love enemies as well as friends, the sinful and miserable as well as the holy and happy; to rejoice and give thanks for every thing he sees and feels, however irreconcilable to his present suggestions; and to labour, as an instrument under God, with real courage and consistency, for the promotion of virtue and happiness.

97. In like manner the conscience or moral sense requires a perpetual direction and support from the love of God, to keep it steady and pure. When God is made only a subordinate end, or is shut out from the mind, men are very apt to relapse into negligence and callosity, and to act without any virtuous principle. And, on the other hand, if they regard him with slavish fear, they fill their minds with endless scruples and anxieties about the lawfulness of trivial actions. Thus it regulates, improves, and perfects all the other parts of our nature; but further, it affords a pleasure superior in kind, and in degree, to all the rest of which our nature is capable.

98. First, the love and contemplation of God in some measure renders us partakers of the divine nature, and consequently of the perfection and happiness of it. Our wills may thus be united to his will, and, therefore, rendered free from disappointment; we shall, by degrees, see every thing as God sees it, that is, see every thing which he has made to be good. Though this can only be the case in part in the present world, yet it is well known that there have been those who have so far reached this perfection of our nature, as to acquiesce, and even to rejoice in the events of life, however apparently afflicting; to be freed from fear and solicitude; and to receive their daily bread with constant thankfulness. And though the number of these happy persons has been comparatively small, and the path be not frequented and beaten, yet, if the desire be sufficiently earnest, it is in the power of all to arrive at the same state.

99. Secondly, the love of God may be considered as the central affection to which all the others point. When men have entered sufficiently into the ways of piety, the ideas of the Supreme Being recur more and more in the whole course

and tenor of their lives, and, by uniting with all their sensations and intellectual feelings, overpower all the pains, and augment and connect with themselves all the pleasures. Every thing beautiful and glorious brings in the ideas of God, mixes with them, and coalesces with them; for all things are from God, he is the only cause and reality, and the existence of every thing else is only the effect and proof of his existence and excellence. Let the mind be once duly imbued with this truth, and its practical applications, and every thing will afford exercise for the devout affections.' Add to their unlimited extent, their purity, and perfection, and it cannot but be acknowledged, that they must be far superior to the rest, both in kind and in degree.

100. Thirdly, the objects of other pleasures are frequently removed. No time, no place, no circumstance of life, can deprive us of this. Our hearts may be directed towards God in the greatest external confusion, as well as in the deepest silence and retirement. All the duties of life, when directed to God, become pleasures, and by the same means, every the smallest action becomes the discharge of the proper duty of time and place. Thus time is turned to its best advantage: thus every situation of life may be converted into present comfort and future felicity.

101. Fourthly, when the love of God is thus made to arise from every object, and to exert itself in every action, it becomes of a permanent nature, and will not pass into deadness or disgust, as those other pleasures do from repeated gratification.

102. We should be glad if our limits would allow of our laying before our readers a view of those means which are pointed out by Hartley, for the culture of the theopathetic affections, of faith, fear, gratitude, hope, trust, resignation, and love: we must, however, content ourselves with referring to his 72d proposition on this point, and to his important rules in the 73d proposition, concerning the manner of expressing them in prayer, and other religious exercises; concluding this head with the following observations from the latter. There cannot be a more fatal delusion, than to suppose that religion is nothing but a divine philosophy in the soul; and that the foregoing theopathetic affections may exist and flourish there, though they be not cultivated by devout exercises and expressions. Experience, and many plain obvious reasons, shew the falsehood and mischievous tendency of this notion; and it follows from the theory of association, that no internal dispositions can remain long in the mind, unless they be properly nourished by proper associations, that is, by some external acts. This, therefore, among others, may be considered as a strong argument for frequent prayer.

VII. ESTIMATE OF THE PLEASURES OF THE MORAL SENSE.

(PHILOSOPHY, *mental*, § 92—99.)

103. It has already been stated, that the moral sense ought to have great influence even in the most explicit and deliberate actions; hence the culture of its pleasures, and the correcting of its dictates, should be made a primary object of pursuit. Further, the moral sense, on urgent occasions, ought to have the sole influence: and this for several reasons.—First, because it offers itself at the various occasions of life, with consistency, and generally with certainty. It warns us beforehand, and calls us to account afterward; it condemns or approves; it rewards by the pleasures of self-approbation, or punishes by the pains of self-condemnation.—Secondly, the moral sense is principally generated by piety, benevolence, and rational self-interest. All these are explicit guides in deliberate actions; and since they are excluded, on sudden occasions, through the want of time to weigh and determine, it is highly reasonable to admit the moral sense formed from them, and whose dictates are immediate, as their substitute.—Thirdly, the greatness, the importance, and the calm nature, of the pleasures of the moral sense, with the horrors and the constant recurrence of the sense of guilt, are additional arguments, to shew that these pleasures and pains were intended as the guides of life.

104. The perfection of the moral sense consists in the four following particulars: that it extend to all the actions of moment which occur in the intercourses of real life, and be a ready monitor on all such occasions: that its pleasures and pains should be so vivid as to furnish a very strong excitement to shun the path of vice, and to walk steadily in the way of religion: that it should not descend to trifling or minute particulars; for, though scrupulosity is probably a necessary step in the progress of the mind to moral excellency, yet, if it continue and become the prevailing habit of the mind, it will check benevolence, and turn the love of God into a

superstitious fear: lastly, it is necessary that the pleasures and pains of the moral sense should be perfectly comformable to the dictates of piety and benevolence, of which it may be considered as the substitute

105. In order to obtain the most perfect state of the conscience, it is necessary for us to be much employed in the practical study of the sacred writings, and of the good of all denominations; in observing the living examples of goodness, and in the perusal of christian biography; in self-examination, and in the culture of the sympathetic and theopathetic affections; and in aiming to follow, with faithfulness, the dictates of piety, benevolence, and the moral sense, such as they are at present.

106. The moral sense may be, and often is, misled by education; the dictates of this feeling, therefore, are not a perfect and infallible guide; though in persons well educated they are decidedly favourable to virtue. Hence, to cultivate and enlighten the moral sense in ourselves and in others, is a duty of the highest obligation; the most disastrous consequences have ensued, both to individuals and to society, from obedience to the dictates of misguided conscience.

107. Character, to use (with some variations) the words of Mr. Belsham, from whose Elements we have taken the last paragraph, is the sum total of moral habits and affections. That character is perfectly virtuous, all whose affections and habits tend to produce the greatest ultimate happiness of the agent, that is, in which all are perfectly consistent with pious benevolence, and in which every moral habit and affection is advanced to its most disinterested state. That character is perfectly vicious, all whose affections and habits tend to produce the greatest ultimate misery of the agent, and in which every vicious affection and habit exists in its ultimate state. The former character, though possible, is rarely to be found; but the tendency of moral discipline is, to produce a continual approximation towards it; and it will probably be the ultimate state of all the rational creatures of God. The character of perfect vice is impossible; it never can actually exist; for no being can pursue misery for its own sake. That agent is said to be virtuous, though imperfectly so, all whose affections and habits tend to his own ultimate felicity, but not having attained their most perfect state, are subject to occasional deviations from the rules of piety and benevolence. That agent is denominated vicious, but imperfectly so, in whom there is one moral habit which tends to produce misery, or to diminish happiness: for example; intemperance, avarice, dishonesty, impiety. The reason is obvious. The existence of a single habit of this description is inconsistent with the perfect happiness of the agent, and necessarily involves him in proportional misery. So the prevalence of a single disorder is inconsistent with perfect health; and if a remedy be not applied in time, may be productive of the most fatal consequences.

PHILYDRUM, in botany, a genus of the Monandria Monogynia class and order. Essential character: spathe one-flowered; perianthium none; corolla four-petalled, irregular; capsule three-celled, many-seeded. There is but one species, *viz*. P. lanuginosum, a native of China and Cochin-China, in moist places.

PHLEBOTOMY, in surgery, the opening a vein with a proper sharp-edged and pointed instrument of steel, in order to let out a proper quantity of blood, either for the preservation, or recovery of a person's health

PHLEUM, in botany, *cat's-tail grass*, a genus of the Triandria Digynia class and order. Natural order of Gramina, Gramineæ, or grasses. Essential character: calyx two-valved, sessile, linear, truncated, with a two-cusped tip; corolla inclosed. There are four species.

PHOLAS, in natural history, a genus of the Vermes Testacea class and order. Generic character: animal an ascidia; shell bivalve, divaricate, with several lesser differently shaped accessory ones at the hinge; hinges recurved, united by a cartilage; in the inside beneath the hinge is an incurved tooth. There are twelve species; they all perforate clay, spongy stones, and wood, while in the younger state, and as they increase in size, enlarge their habitation within, and thus become imprisoned. They contain a phosphoreous liquor, which illuminates whatever it touches.

PHLOGISTON, in chemistry, a term that seems to be almost wholly banished from our language. It was invented by Stahl, according to whom there is only one substance in nature capable of combustion; this he called phlogiston, and all those bodies which can be inflamed, contain more or less of it. Combustion, by his theory, is merely the separation of this substance. Those bodies which con-

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Kneass, Young [illegible]

Fig.1. Myoxus *nitela: Garden dormouse-Fig.2.*M.*dryas: Wood dormouse Fig.3.* Myrmecophaga *jubata: Great ant eater-Fig.4.* Ovis *aries: common ram-Fig.5. Dwarf sheep Fig.6. Many horned sheep.*

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Fig.1. Motacilla *maderaspatensis: Pied Wagtail*_*Fig.2.* Muscicapa *atricappilla: Pied Fly catcher*–*Fig.3.* Motacilla *regulus: Golden crested Wren*_*Fig.4.* M.luscina *Nightingale* *Fig.5.* Numidia *pintado: Guinea-hen*_*Fig.6.* Oriolus *hœmorrhous: Red-rumped Oriole. Fig.7.* Parus *major: Greater Titmouse Fig.8.* P. *cœruleus Blue Titmouse.*

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Fig. 1. Otis *Tarda : Great Bustard _ Fig. 2.* Pavo *Cristatus : Crested Peacock _ Fig. 3.* Pelecanus *Carbo: Corvorant Fig. 4. P. Bassanus: Gannet _ Fig. 5.* Penelope *Marail.*

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Fig. 1. Elater *flabicornis* – *Fig.* 2. Gryllus *monstrosus* – *Fig. 3.* Lucanus *cervus* – *Fig. 4.* Monoculus *pulex* – *Fig. 5.* Myrmeleon *grande* – *Fig. 6.* Nepa *grandis* – *Fig. 7.* Oestrus *bovis* – *Fig. 8.* O. *equi* *Fig. 9.* Papilio *antenor.*

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Fig. 1.

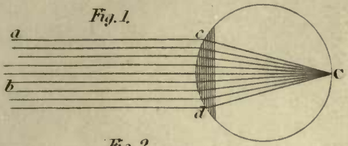
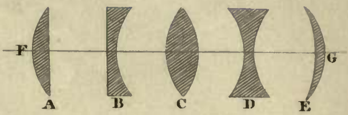


Fig. 3



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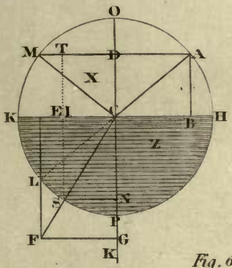

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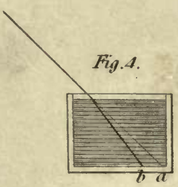

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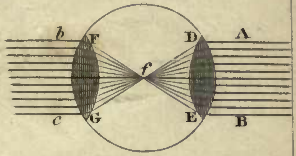

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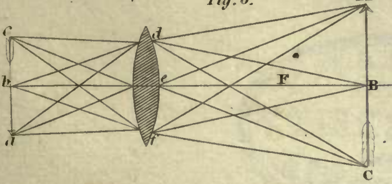

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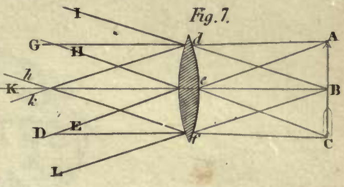

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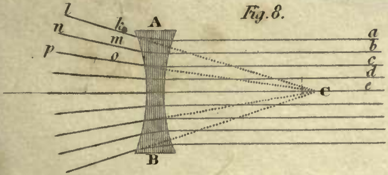

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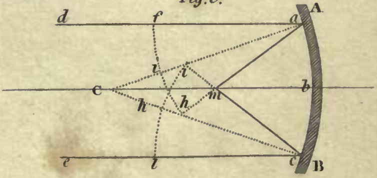

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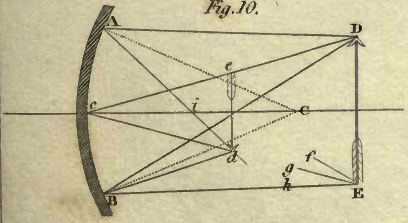

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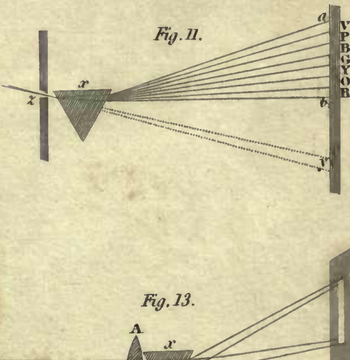

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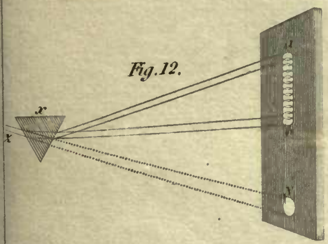

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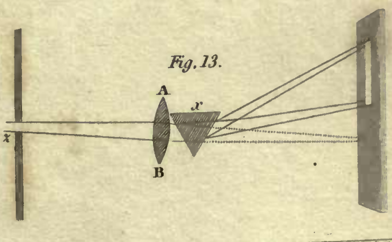

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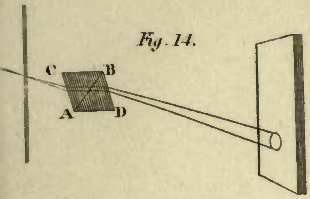
Fig. 14.



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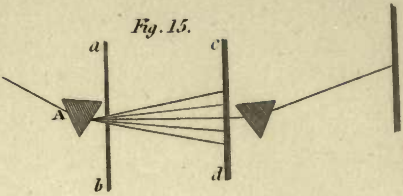

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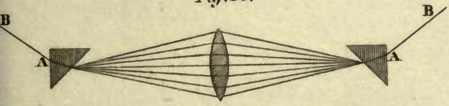

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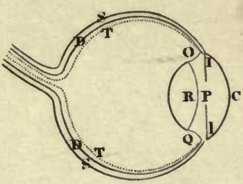

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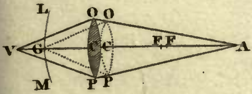

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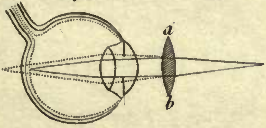

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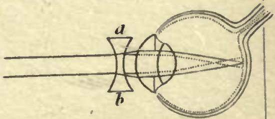

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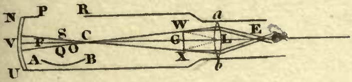

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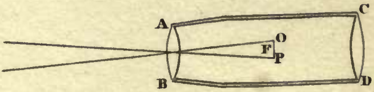

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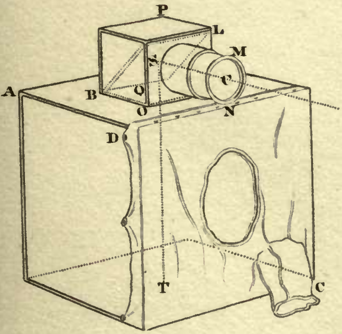

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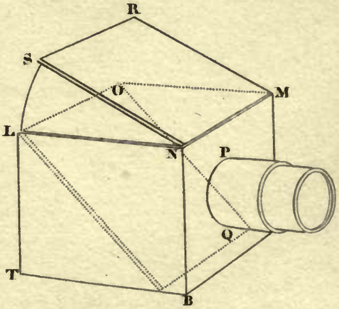

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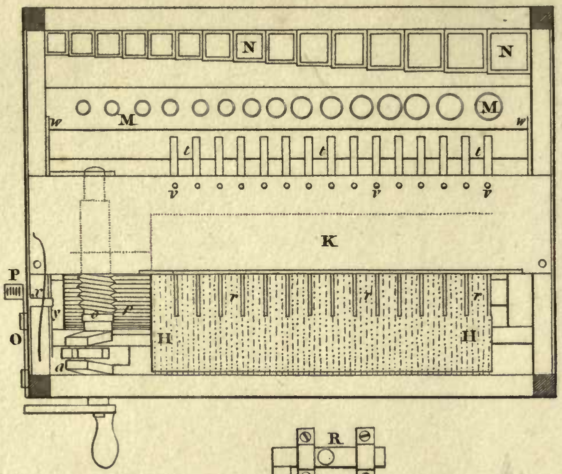
PARTS OF BARREL ORGAN.

Fig. 3.



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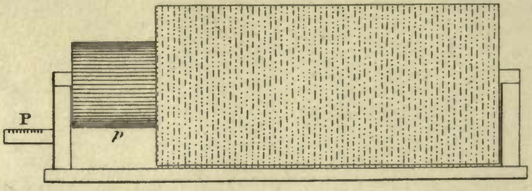

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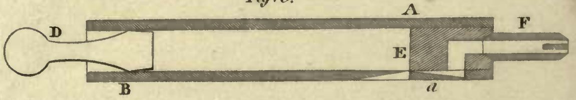

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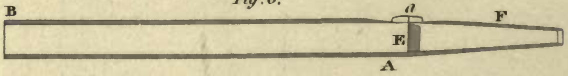

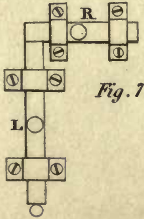

Fig. 7.

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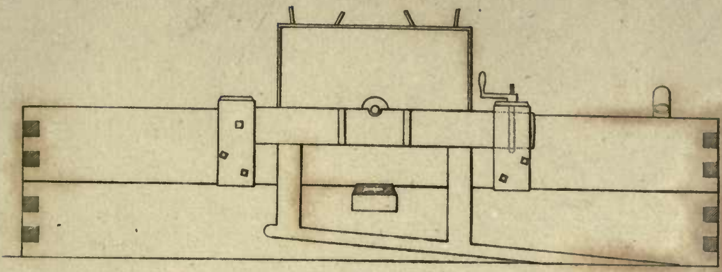
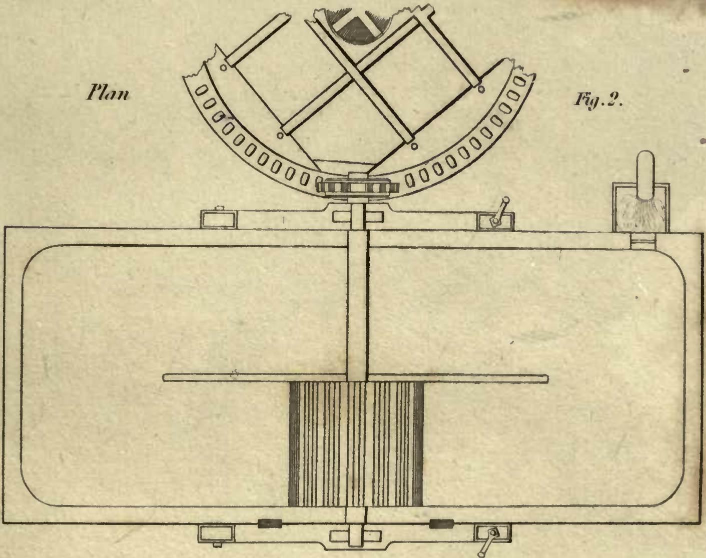
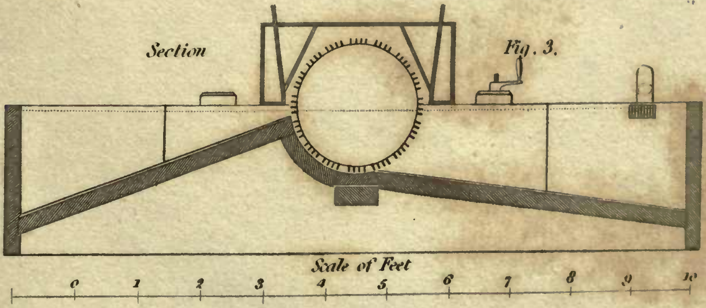
Elevation Fig. 1.



Plan Fig. 2.



Section Fig. 3.



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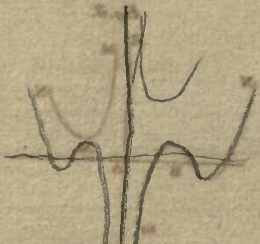

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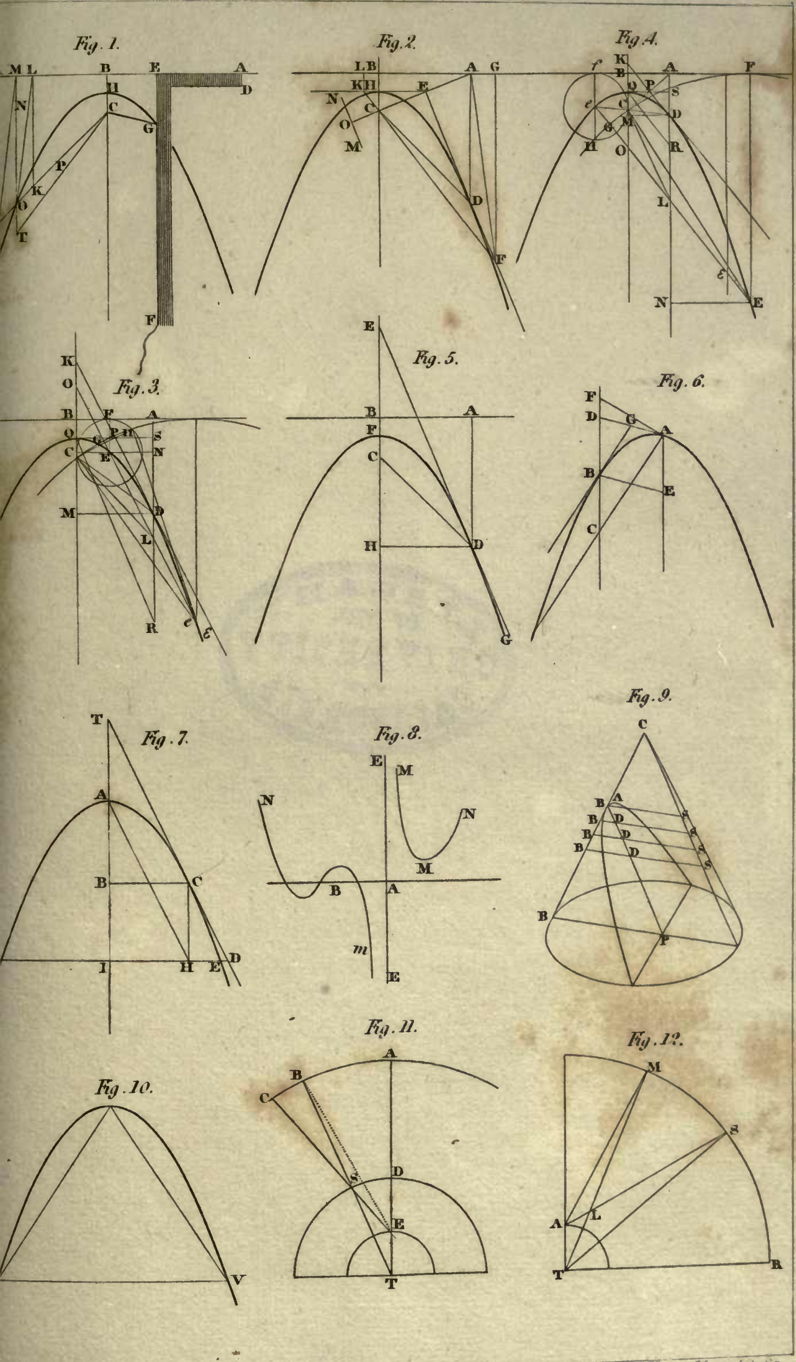

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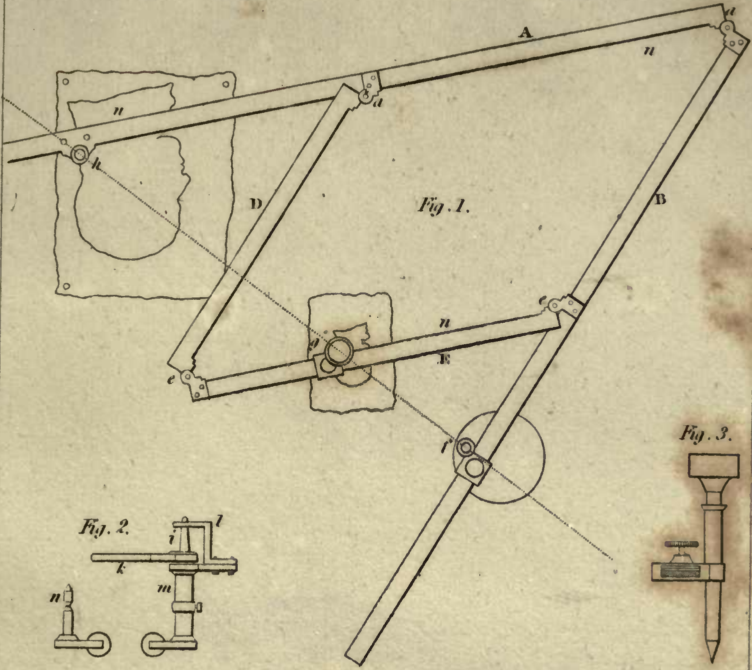

Fig. 1.

Fig. 2.

Fig. 3.

Parallel rulers.

Fig. 4.

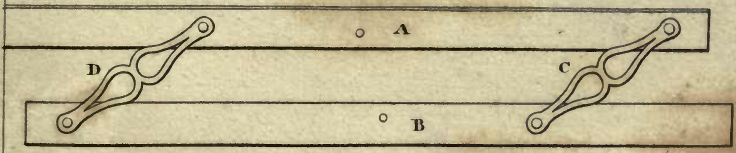

Fig. 5.

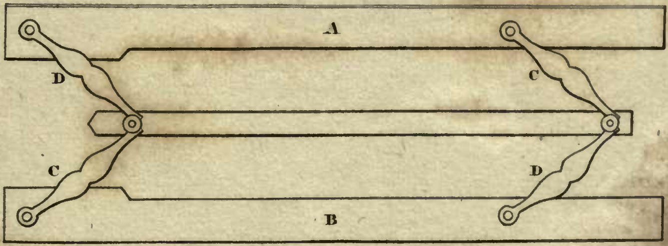

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Fig. 1.

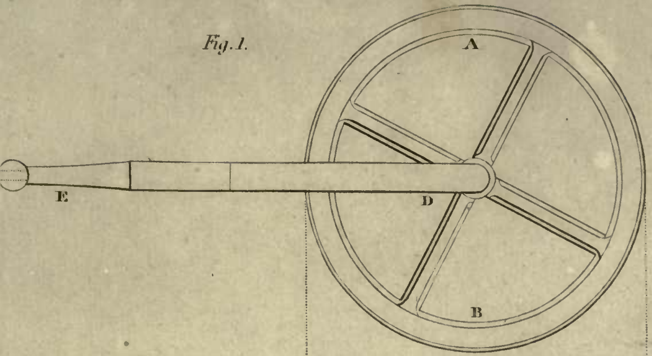


Fig. 2.

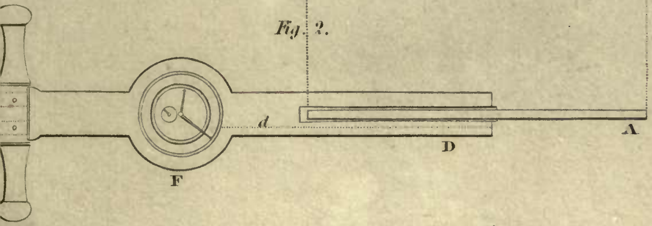


Fig. 3.

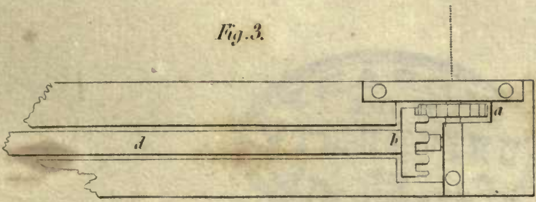


Fig. 4.

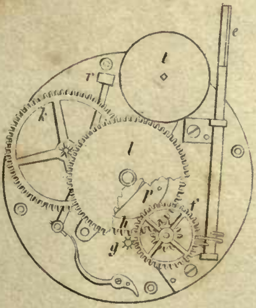
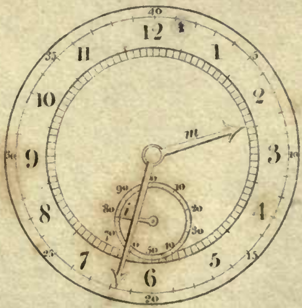


Fig. 5.



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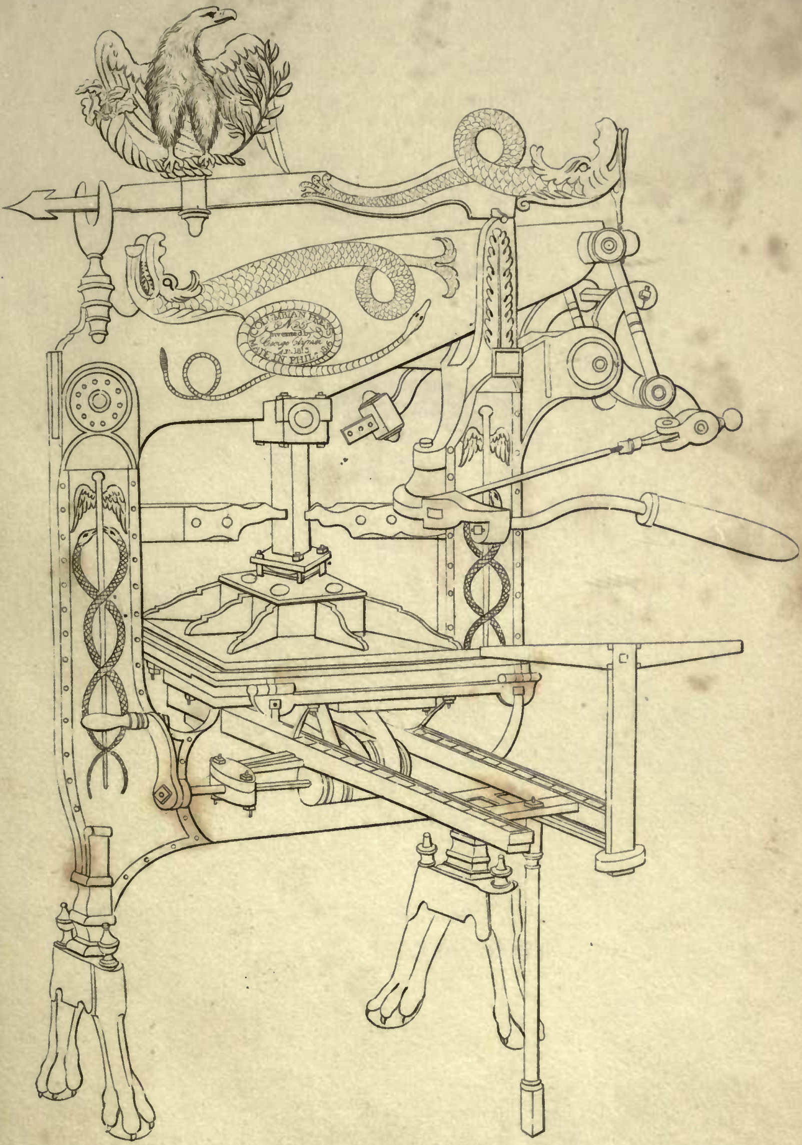

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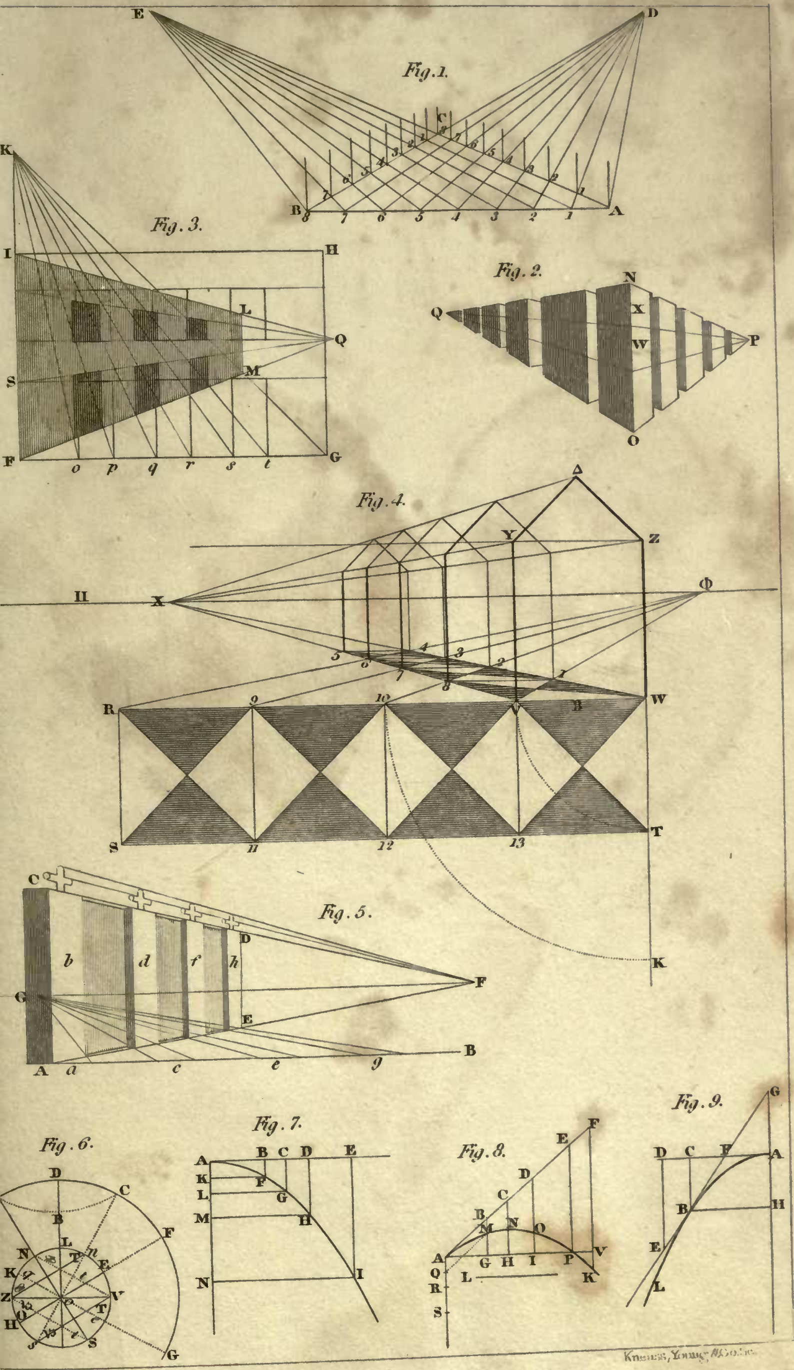

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Plate XVII.

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